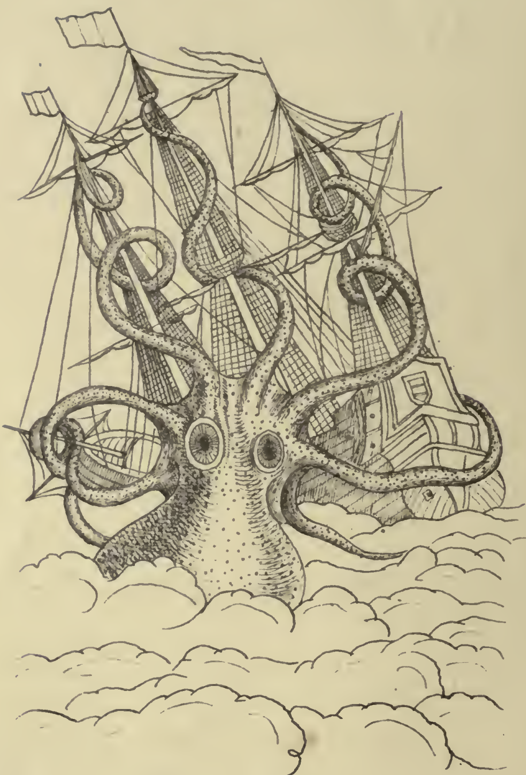
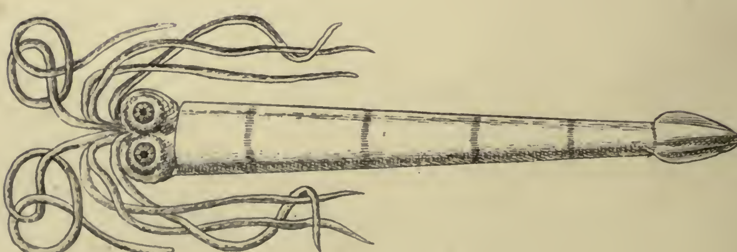
CEPHALOPODA.





MANUAL

OF

CONCHOLOGY;

STRUCTURAL AND SYSTEMATIC.

WITH ILLUSTRATIONS OF THE SPECIES.

BY GEORGE W. TRYON, JR.

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ADVERTISEMENT.

I propose to compile a Conchological Manual, which, whilst more comprehensive than any similar work hitherto published, shall be so condensed in text and illustration that it may be issued at a much more moderate price. It will include, in systematic order, the diagnoses of all the genera and higher divisions of the mollusca, both recent and fossil, and the descriptions and figures of all the recent species; together with the main features of their anatomy and physiology, their embryology and development, their relations to man and other animals, and their geological and geographical distribution.

The material at my disposal for the purpose of working up this comprehensive plan is ample and unexcelled:

I.—The Library of the Academy of Natural Sciences of Philadelphia contains almost every separate work ever published upon the subject, together with the various volumes of voyages and travels, of general natural history, and especially scientific periodicals, and the published transactions of learned societies throughout the world. For Conchological purposes this library is almost complete, and it is very rarely that its shelves do not afford any reference desired.

II.—The Conchological Museum of the same institution ranks among the largest in the world in the number of species represented, whilst in the richness of its geographical suites, the number of specimens illustrating varietal forms, etc., it is probably the finest collection extant.

It is intended to arrange and describe the valid species in accordance with their inter-relationships, and it is hoped that by so doing their number may be greatly reduced. Every genus and every recent species will be fully illustrated, so far as specimens or hitherto published figures will enable me to do so. The experienced skill of Dr. E. J. Nolan, who has undertaken to furnish the illustrations (of which 30,000 to 40,000 will be required), will sufficiently guarantee the accuracy of this department of the Manual.

In the preparation of the text every care will be taken to discover and correct, and to avoid, error; but it may be reasonably apprehended that the performance of such an immense work must be in many respects inferior to its design: the imperfection of human judgment, the uncertainty arising from paucity of material in some cases, in others, perhaps, the bewilderment caused by its redundancy, are fruitful sources of error which will occasionally waylay and mislead the most honest, thorough and patient investigator. I cannot hope to escape them; but I shall take note of all corrections, as well as of such additional information as may hereafter become accessible to me, in order that these may be incorporated in appendices, or perhaps in additional volumes, to be published from time to time, whenever the accumulation of such material may render them necessary.

I feel that the work I propose to undertake is a worthy one; that its completion will enable the Conchologist *for the first time* to identify and to learn the history of all the species in his cabinet without the necessity of consulting many extensive and costly monographies, besides thousands of fugitive papers. Towards the completion of this task I ask the sympathy and aid of all interested in Conchological pursuits.

GEORGE W. TRYON, Jr.

CEPHALOPODA.

ANATOMY.

External Features.

Cephalopod mollusks are immediately distinguished from all other classes of the mollusca by the circle of acetabula or arms which surrounds the head; these may be regarded as homologous with the foot of the gasteropods, with its margins produced into the eight or ten processes which are indifferently designated as arms, acetabula or brachia. The extension of this modified foot around the mouth of the animal, its manifold uses in its economy and its high structural development, combine to place the cephalopoda at the head of the mollusca.*

The mouth is supplied with a pair of calcareous or horny jaws, resembling in form the beaks of a parrot. The arms proper, in the naked cephalopods, are eight in number, and are distinctively called sessile arms, to distinguish them from the tentacular arms or tentacles, much longer, and capable of retraction within pouches, which are additionally possessed by those species which have an internal shell or cuttle-bone. The sessile arms are provided with suckers or hooks for prehension, covering their interior surface, whilst the tentacles are expanded into club-shaped terminations similarly armed. In the Nautilus, sole living representative of an exceedingly numerous extinct order, the arms degenerate into numerous tentacles, unarmed, which are retractile into eight sheaths, morphologically representing the

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* The nervous system and phylogeny of the cephalopoda have been studied by Hermann von Jhering (Leipzig, 1877), who states as a result of his researches upon the homologies of the gangliæ and nerves, that the arms of the cephalopods in no way represent the foot of the gasteropoda, but are tentacular growths of the head; that the only part of the cephalopod analogous to the foot of the gasteropod, is the siphon.

typical eight arms. In this animal only, the body is contained within, and protected by, an external shell, which compensates to it the loss of offensive and locomotive power possessed by its more highly organized allies.

Behind the arms, the circle of which may constitute its *crown*, that major portion of the *head* is situated which is usually distinctively so designated; its dorsal aspect exhibits on either side an *eye*. The head may be joined to the body by a more or less constricted *neck*, or is frequently sessile upon the latter, without intervening constriction. The body, or mantle, is dorsally more or less continuous with the head, but ventrally forms a sack anteriorly open, and from which emerges the *funnel* or *siphon* (which may also be regarded as a modification of a portion of the foot of the gasteropoda). The sack or body is, in a small portion of the octopod and in the decapod species, expanded into postero-lateral membranes, possessing the power of undulatory motion, and which may be considered as the equivalent of *fins*, in function, though not in appearance.

The Skin.

The epithelium in the dibranchiate cephalopods, is composed of flask-like or rounded grain-like cells; they are cylindrical in the Nautilus. Under this lies a thin fibrous layer, which again covers that containing the chromatophores. The skin of the cephalopod, particularly its dorsal surface, is covered with apparently minute specks of a dark reddish color, which are, in reality, the pigment cells or chromatophores (Pl. 12, f, 8, 9); these are each provided with radiating muscles, by which, at the will of the animal, the little sacks are greatly dilated, and the color becomes intensified. The rapid chameleon-like changes of color peculiar to the cephalopoda among mollusca, are thus produced; whilst the accompanying opal-like and silvery appearance exhibited by the cuttle-fishes, is due to a thin layer underlying the pigment layer, and reflecting through it. In the tentacles of Nautilus are found epithelial pigment cells, which, according to Rumphius, are used similarly to the chromatophores.

The outer skin, in many of the genera, is furnished with contractile tubercular elevations or *beards*, which are raised when the animal is irritated, and give it a rather ferocious appearance. These beards are disposed in symmetrical patterns, upon the dorsal surface, and particularly around the eyes, and their number and position form available distinctive characters.

It will be readily understood, from the above, that *color* is scarcely characteristic of species in the cephalopoda, and that care is necessary to separate these surface elevations, which may be considered permanent from such as are due to the will of the animal. The littoral species of Octopus, etc., which ordinarily await their prey, instead of pursuing it like the finned pelagic species, seem to possess and exercise, to some extent, a power of color mimicry, in preventing their victims from distinguishing them from circumjacent objects.

Cartilages (*Plate* 1).

The cartilaginous supports of the principal nerve-gangliæ are well-developed, sometimes completely enveloping them; besides which the principal organs of sense, the valves of the mantle, the fins, etc., are duly provided.

As might be expected from its habits, the cartilaginous system of the Nautilus is the most simple of all the cephalopods, consisting of a well-developed head-cartilage, so shaped and situated as to support the œsophageal ring, the cerebral and pedal commissures, whilst two prolongations of it serve the funnel or siphon.

In the dibranchiata, unlike the Nautilus, the head-cartilage forms a complete ring around the œsophagus: from the medial line of the back of this ring spring two lancet-form cartilaginous processes, the cartilages of the eyelid, and the under side of the same ring spreads into a spoon-shaped process which comes far forward and supports the eyes; particularly when, as in Sepia, it reaches to the sides of the head and encompasses the ocular opening.

The cartilages of the back and of the fins are shown in position in Plate 1, fig. 1, after Keferstein, of *Sepia officinalis*. In the Loligos the moon-shaped cartilage of the back is wanting, but is replaced in its functions by the upper end of the corneous pen or inner shell. In the Octopods there remains only of this back-cartilage its two narrow posterior blade-like projections (*d*, same fig.). In the genus Cirroteuthis, an anomalous Octopod of which only a single species is known, the dorsal cartilage is very broad, so as to simulate the internal shell or pen of the decapod. At the entrance of the anterior ventral mantle opening is found a singular cartilaginous mechanism, which d'Orbigny has called the "appareil de résistance," peculiar to the cephalopoda, which consists of buttons or ridges and corresponding grooves placed on the opposed inner side of the mantle and the body, and by which the animal may at will button its head to the mantle to prevent the injury which might otherwise result to it during a struggle with wave or prey, in consequence of its want of support there (Plate 1, fig. 2). On the other hand, by relaxing this support the animal preserves for itself a freedom of movement of head and arms which would be impracticable were these as permanently and closely connected with the body on the ventral as they are on the dorsal side. The arrangement of this resisting apparatus varies in different genera, and is a good distinctive character. Largely developed in those species which have no fixed attachment to the body, as in Ommastrephes, Loligo, etc., it exists also in those genera which possess only a very small cervical band of attachment, as in Argonauta, but it is wanting in those genera in which the permanent bands are well-developed, as in Octopus, Cranchia, etc.

In Philonexis or Tremoctopus, a button is found at the base of the siphon tube, with a corresponding groove to receive it upon the inner wall of the mantle, but in Argonauta the relative position of button and buttonhole is reversed. In Rossia we find a short ridge surmounted by a profound groove opposed to an elongated groove on the base of the siphon; in Loligo and Sepioteuthis (fig. 2) the ridge is somewhat longer, without grooves; in Onychoteuthis and Enoploteuthis the ridge is nearly half the length of the body, with the siphonal groove; in Sepia an oblique oblong button can be fixed into a similarly formed pit upon the siphon; in Chiroteuthis there are an oblong longitudinal button and two lateral pits fitting into a central pit and two buttons on the siphon; finally, in Ommastrephes, in which it is most complicated, there are two projections, one oblong and the other triangular, entering cavities upon the siphonal tube, and two projections upon the latter which enter between the tubercles of the opposed mantle. The complexity of this attachment increases, it will be perceived, with the activity of the animal, and in the comparatively sluggish littoral genera it is not found at all.

Internal Shell.

This is found only in the dibranchiate cephalopods, and amongst them only fully developed in the decapod division, *i. e.*, among the pelagic species, whose quick movements require the support to the body which the shell affords; nevertheless, it is prefigured in the cartilaginous blades lodged in the back of the Octopods, and is more fully developed in the single Octopod genus, Cirroteuthis, which possesses the means of more rapid motion in its large web or umbrella.

The internal shell is simple, usually, in form, being a blade or pen lodged in a pouch or slit in the back of the mantle, with an anterior, more or less specialized, prolongation of its rhachis or quill. The internal shell is either horny or chitinous and transparent, as in Loligo, or a spongy, chalky mass, as in Sepia, or calcareous, as in the fossil Belemnites, or mother-of-pearl, as in Spirula; in the latter, only, taking the spiral form of the external shells of the tetrabranchiate cephalopods.

The feather-shaped horny shell of the Loligo resembles, and is called, a *pen*, and its rhachis, prolonged in front like a quill, completes the resemblance. This rhachis is on the ventral side, when the pen is lodged in the mantle. The wings, or lateral projections, are, commonly, broader in the female than in the male individuals.

When the shell is both corneous and testaceous, as in Sepia, among recent genera and in several fossil forms, it may consist of a thin, horny blade, occupying the entire dorsal surface of the mantle, with an underlying spongy calcareous mass attached. In Sepia we find, always, the so-called ærial chambers obliquely placed and not connected by a siphon, and sometimes terminated by a sharp rostrum, whilst in fossil genera, as Beloptera, these chambers are arranged in a single line, or in Spirulirostra they become a spiral series, connected by a siphon and analogous to the shell of the Spirula; which latter is free in the mantle, without the envelopment of the spongy mass. In another group of fossil forms, the long shell is composed of a narrow or broad anterior corneous portion, and a posterior calcareous part containing the ærial chambers, placed one upon another and siphunculated. These chambers are only covered with shell in Conoteuthis; but they are protected in the Belemnites by a testaceous rostrum, sometimes very long, which, absolutely identical with that of Sepia, is composed of successive very compact radiating layers.

The study of the shell is of great zoölogical importance, as its form and composition vary characteristically in the different genera; and it becomes still more important geologically, inasmuch as it is almost the only portion of the vast number of fossil species which has been preserved to us; and by the study of it in comparison with recent species, we are enabled not only to distinguish the species and genera of these extinct forms, but even to predicate the external appearance, the physiology, the anatomy of the animals, with nearly the accuracy with which the vertebrate palæontologist reconstructs a mammal or a reptile from its osseous fragments.

The study of the internal shell, considered as to its functions in the animal economy, demands some further consideration. These functions, by reason of modifications of structure, are threefold:

1. If the internal shell is a corneous blade, it becomes simply a support to the flesh, fulfilling the office of the skeleton in mammals.

2. When it is corneous or testaceous, and containing parts filled with air, as in the alveola of the Belemnites, it additionally represents among mollusks the swimming bladder of fishes. These air-chambers may consist, as we have seen, of an oblique series, separated in their interior by a crowd of small diaphragms, filled with air, and attached to the under side of the blade or cuttle-bone, as in Sepia; or even of a series of chambers taking a definite spiral form, as in Spirula. D'Orbigny shows that shells of this second division, when parted from their animals, are sufficiently light to float upon the surface of the waves, and that there is a constant coincidence of the progressive augmentation of the number of air-chambers with the growth of the animal, in

order to maintain an equilibrium.* In effect, the Sepia and the Spirula animals of massive proportions, have need of this aid in swimming; and it is more plentifully supplied to the round-bodied Spirula, than to the Conoteuthis, for example, the form of which denotes an animal infinitely more agile. In the Belemnites the aerial chambers doubtless compensated the enormous weight of the calcareous rostrum, which would otherwise have compelled the animal to maintain a vertical position in the water, or prevented horizontal movement, except at great disadvantage to its strength. (In the chambered external shells of the tetrabranchiates, represented amongst the extinct genera by the spirally-coiled Ammonites, and other genera, and largely developed in species, but of which the Nautilus is the sole recent example, the air-chambers may possibly compensate the weight of superincumbent water, and facilitate its crawling movements, if, as is now generally supposed, the Nautilus is not a swimming animal, and does not voluntarily leave its ocean bed. The immense size and weight of the Nautilus shell, capable of containing the entire animal within its last chamber, the absence of long arms, or web or fins, all seem to favor this supposition as to its habits.)

3. Owing to their narrow posterior and massive anterior form, as well as to the normal direction of the siphon and the frequent use of the webbed arms in swimming, the cephalopods are able to progress through the water more rapidly in retrograde than in forward motion; and this swimming is a succession of darts made with great velocity. Here the calcareous rostrum, as in the Sepia, and which is so largely developed in Belemnites and other fossil genera, comes into use as a body-protector, in receiving and withstanding the shocks of accidental collisions. It is only among the swimming species that this protection is needed, and it is most required, and consequently most developed, in those which inhabit the vicinity of the coasts, like the Sepia.

Internal shells, having no aerial chambers, show no *nucleus*, and do not change their forms at different periods of their growth; but in those furnished with the air-chambers, a distinct

* The lightness of the shell of the Sepia is partly due to a contained gas, which Dr. Paul Bert has succeeded in obtaining in small quantities, by opening the sack of the animal under water.

nucleus is observed, indicated by the more globose first chamber, as in Spirula and Belemnites. It is amongst these latter shells that we find considerable modifications arising from age, sex or pathological causes. The changes resulting from age are, above all, visible in the rostra of the Belemnites, which, ordinarily slender when young, are thickened and shortened with advancing age. In exceptional cases, these rostra, when their growth is completed, present, at their extremity, very remarkable tubular prolongations. Modifications due to sex, are shown in the difference in width of the shell in Loligo, in the more or less elongated rostrum of Belemnites, perhaps, or in the prolongations of which we have just spoken. Pathological modifications are very numerous, above all in Belemnites. They may change entirely the form of the rostrum, by rendering it obtuse, or even cause those strange mutilations upon which the genus Actinocamax is founded.

The Spirula, the sole survivor of a large group of internal concamerated shells, is peculiar in being formed exclusively of pearl (the Nautilus has an internal pearly layer); it hangs free in the hinder end of the body, held in place solely by lateral thin lappets of skin proceeding from either side of the mantle, and connate below the whorls, with a prominence at their junction. A small portion of the intestinal sack occupies the last chamber of the shell, and a prolongation of it connects the chambers by passing through the siphonal tubes which penetrate the septæ towards their inner margin (instead of in the middle, as in Nautilus).

In the fossil Belemnites, the siphunculated, chambered portion of the shell has been called the *Phragmoconus*, by Owen; the horny or chalky blade is termed, by Huxley, the *pro-ostracum*, and the *rostrum* of the latter author corresponds with the similar term heretofore used by us.

Analysis shows the horny shell to be principally composed of chitin. The *Sepia officinalis*, according to J. F. John, yields of

Carbonate of Lime, with a trace of Phosphate,	85°
Water,	4°
Organic matter,	4°
Residuum, Magnesia, etc.,	7°.

M. Munier-Chalmas has recently endeavored to prove that the Ammonites are not tetrabranchiate cephalopoda, allied to the Nautili, but dibranchiate decapods, having the greatest affinity to the Spirulæ. As early as 1867, Barrande had shown the small resemblance that exists between the Goniatites and the Nautilidæ, during the first period of their development. The initial chamber of the phragmostracum in the Nautilidæ, does not sensibly differ, in its general organization, from the other primary chambers which are developed a little later; whereas the initial shell of the Goniatites appears in the form of an *egg*, isolated from the first air-chamber by a distinct constriction. This initial chamber or ovisac, of the Goniatites, so different from those which immediately succeed it, is met with at the origin of the phragmostracum of all the dibranchiate mollusca that M. Munier-Chalmas has been able to study. Mr. Alpheus Hyatt's very interesting investigations upon the embryogeny of the phragmostracum of *Nautilus Pompilius*, *Deroceras planicosta*, and the Goniatites, come in support of these observations. Mr. Hyatt, however, preoccupied by his theoretical ideas upon the evolution of living creatures, in order to establish the affiliation of the Ammonites and Nautili, supposes that the latter lost their ovisac by truncation. To support this supposition, he adduces the transverse external cicatrix which he observed on the initial chamber of *Nautilus Pompilius*. The comparative examination which M. Munier-Chalmas has made of the ovisacs of *Spirula Peronii* and of *Ammonites Parkinsoni*, and other species, has shown that in these mollusks the siphon originates in the ovisac a little before the appearance of the first septum. It commences by a cæcal inflation, which bears the prosiphon in its prolongation. The new organ, to which he gives the name of prosiphon, must take the place of the siphon during the embryonic period. It originates in the ovisac, opposite the siphonal inflation, upon which it terminates, but without having any internal communication therewith. It is very variable in its general form, and may present strongly marked examples of dimorphism in the same species of Ammonite. It is formed by a membrane, which is sometimes simply spread out as in *Spirula Peronii*, or which may form a more or less circular tube. It also presents two, three, or four small subdivisions at its point of insertion upon the inner wall.

The presence of an ovisac has been ascertained by M. Chalmas in a number of fossil cephalopods, Belemnites, Ammonites, Ceratites, etc. It is generally spheroidal when the turns of the spire are free, and ovoid when they are contiguous. But in the living tetrabranchiate cephalopoda, as well as in the remains of the many extinct species, the presence of an ovisac has never been detected. In *Nautilus* and *Aturia*, the siphon originates upon the inner walls of the first chamber. It is completely closed at its posterior extremity, by a part of the calcareous prolongation of the septum, which assists in its formation. The external transverse cicatrix observed by Mr. Hyatt, can never have been in communication with the siphon; its purpose is still completely unknown. It has been indicated, by M. Barrande, upon a great number of Silurian tetrabranchiata.

Thus it results, from these observations, that at the Silurian epoch the tetrabranchiate cephalopoda were as clearly separated from the dibranchiates, as at the present day. The only modifications that we can recognize are of generic rank; in fact, the Ammonites, which, when young, have septa like those of Deroceras and Goniatites, appear to be derived from one of those types.*—*Ann. Mag. N. Hist.*, 4th ser., xiii, 184, 1874 (from *Comptes Rendus*, 1873).

External Shell.

Regarding the testaceous nest of the female Argonaut as a shell, it is the only genus which is unilocular; in all the others the external shells being divided by partitions into chambers, connected by a siphon. The Argonauta, of a peculiar fibrous, corneo-calcareous texture, is distinguished by the want of a nucleus in its infancy, and by its composition of two layers, one

* Gray, first in his "Synopsis of the British Museum," 1840, and afterwards in *Ann. Mag. N. Hist.*, xv, 1845, has expressed the opinion that the fossil Ammonites were internal shells, like Spirula, and consequently, dibranchiates instead of tetrabranchiates; and the different plan of the initial chamber, as justly observed by Munier-Chalmas, Barrande, Hyatt and Fischer, is corroborative of this. I do not venture to change the position of these fossils, and do not think any change desirable until we shall be able to understand their history more completely.

placed upon the other. It is secreted by the palmate arms of the female, which are constantly applied to its sides and envelop them In the male Argonaut, always much smaller, there are no palmated arms, and consequently, no shell. The shell itself appears to be useful only as a portable cradle for the development of the eggs, and the animal which forms it does not appear to differ greatly from the shell-less Octopus.

The question of the parasitism of the animal of the Argonaut in its shell, originally assumed by distinguished naturalists, has been so long debated, that quite a literature upon the subject has accumulated. The want of attachment of the animal by adductor muscles, and the fact that the shell itself is not moulded on the animal's body, nor does it correspond to the shape of the latter, were so strong evidence of parasitism, that the animal itself was described as Ocythoë, and the shell as Argonauta. The observations of Madame Jeanette Power first set this vexed question at rest, by showing that the animal builds its shell by the exudation of material from the expanded or velamentous arms ot the female, instead of from the mantle, as in true molluscous shells.

The texture of the Argonaut shell, or egg-nest, is porcellanous, composed of small plates or prisms; its earlier portion is covered with a chagrined cuticle, and its toothed periphery is stained with brown. On either side the velamentous dorsal arms are applied to its external surface, and not only do they add to the margin when growth takes place, but they suffice also to renew any broken portion of the already existing walls.

In a specimen of *Argonauta Argo*, which forms a part of the collection of Amherst College, a portion has been broken out near the middle of the left side, and not far from the sinus of the aperture. A new deposit of testaceous substance, together with a broken fragment, has closed the opening in the rude manner common in the shells of the mollusca. But the most extraordinary circumstance is that a fragment which was broken out in the accident which befel the animal, now constitutes two-thirds of the repaired portion, and that the original inner surface is now the outer surface, as is evident from its concavity, style of undulation, and texture. It is also nearly at right angles to its original position. These facts show that the piece was totally detached from the shell by the accident. The vela of the Argonaut, by clasping and enveloping the shell, had evidently prevented the loss of this fragment. It is obvious, also, that the new deposit of testaceous matter was secreted from the part of the animal within the shell, and not from the vela, since the edges of the original shell around the fracture appear exclusively on the outside.—C. B. ADAMS, *Am. Jour. Sci.*, 2 ser., vi, 138, 1848.

Madame Power has seen the fractured shell of an Argonaut partially repaired by membrane in less than six hours.

The subjoined notes of an accurate modern naturalist afford conclusive evidence of the non-parasitism of the Argonaut.

On our passage home across the South Atlantic, I enjoyed numerous opportunities of observing the animals of *Argonauta argo* and *gondola* in the living state, specimens having been captured by us in large numbers by means of a trawl, as they came to the surface of the water at the decline of day in calm weather, in company with Carinaria, Hyalæa, Firola and Cleodora. My observations all tend to prove, as might have been expected, the accuracy of Madame Power's observations on the cephalopodic origin of the shell, and the fanciful nature of the statements of Pliny, Poli, and the poets.

It is quite true that the female Argonaut can readily disengage herself from the shell, when the velamentous arms become collapsed, and float apparently useless on each side of the animal; and it is equally certain that she has not the power, or, more properly, the sagacity to re-enter her nest and resume the guardianship of her eggs. On the contrary, she herself, if kept in confinement, after darting and wounding herself against the sides of the vessel in which she is confined, soon becomes languid, exhausted, and very shortly dies. Numbers of male Argonauts were taken by us, at the same time, without any shells, and this being the season of ovoposition may account for the females, in such a number of instances, being found embracing their calcareous shell-nests, which, so ingeniously formed by the instinct of the mother for the protection of her eggs from injury, resemble, in some measure, those nidimental capsules secreted by many marine gasteropods for the preservation of the immature embryo.

To satisfy myself that the thin shell of the Argonaut is employed by the female merely as a receptacle in which to deposit her eggs, I dissected a specimen of *A. gondola*, with an egg-mass occupying the discoidal part of the shell and the posterior portion of the roof. The eggs, very numerous, ovoid, pale yellow, and semi-pellucid, are all united together by a delicate, glutinous, transparent, filamentous web, which is attached to each ovum by a slender tapering peduncle at the anterior extremity. The entire egg-mass is suspended to the body-whorl of the spire at its anterior part by means of a pencil of delicate glutinous threads, which retain it in a proper position.

The posterior globular part of the body of the female is in close apposition to the mass of ova, and thus, like a strange aquatic Mygale, or other spider, does this remarkable cephalopod carry about her eggs in a light calcareous nest, which she firmly retains possession of by means of the broad, expanded, delicate membranes of the posterior pair of tentacles. When disturbed or captured, however, she loosens her hold, and, leaving her cradle to its fate, swims about independent of her shell. There is not, indeed, the slightest vestige of any muscular attachment. In a specimen of *A. gondola*, the ovary was distended with ova, but in a much less advanced stage of development than those deposited in the shelly nidus. Some of these latter were sufficiently matured to enable me to trace, under the microscope, the early indications of the being of the Argonaut; and although the progress was not followed very far, it was sufficient to ascertain the similarity with the changes observed by Poli in the same genus, with whose writings I afterwards compared my remarks; the only difference of any importance appears to be that Poli regarded as the shell what I have called the yolk-bag. At first the ova are semi-opaque, pale yellow, and apparently speckled minutely, which is owing to the granular yolk; afterwards they become clouded with light-brown blotches, and three dark spots make their appearance, one for each eye and one for the viscera; these spots, in the next stage, approach each other, and a faint outline of the future Argonaut is visible, a club-shaped embryo, rounded in front and tapering behind. The front part is then lobed; a black mark for the horny mandibles is perceived, and the eyes are large and prominent; the yolk-bag, or vitellus, is next seen very distinctly, and the processes extending from the head are more elongated. Here, however, I was obliged to stop, this being the most perfectly developed embryo I could find amongst the ova. The eggs in contact with the front part of the body-whorl of the shell, where the egg-mass is attached by the glutinous threads, are the most forward in their development, while those in the posterior part of the chamber are much less matured.—ARTHUR ADAMS, Zool. Voy. Samarang, 5, 1850.

The multilocular external shells (Nautilus, Ammonites, etc.) distinguish an order of cephalopods breathing by four instead of two branchiæ, and with the arms much reduced in size and subdivided into tentacles. The shells are capable of containing the entire animal in the cavity above the last aerial chamber, to the wall of which it adheres by two strong muscles. These shells are composed of two layers, the external or porcellanous containing the colors, and the internal, which is pearly, and which includes the partitions or septæ. These septæ, which are straight or arcuated in Nautilus, in Orthoceratites, etc., are angulated in Goniatites, and with infinitely ramified lobes in Ammonites, Hamites, Turrilites, and other fossil genera.

The inner pearly layer of the shell, as well as the septa, is formed by the body of the animal, whilst the outer porcellanous layer is constructed by the mantle-margin. There is additionally deposited, on the spire side of the Nautilus shell, a third thin, black, grainy layer, which can be readily scraped off. This substance can be detected also in many fossil tetrabranchiates.

Sandberger finds the hardness of the porcellanous layer of Nautilus, 4·5 to 5·; the nacreous layer, 3·5 to 4·; whilst the specific gravity of the former is 2·665, and of the latter, 1·596.

The structure of the shells of existing testaceous cephalopods is, on the whole, more analogous to that of bivalves than to that of the gasteropods, the three layers of perpendicular laminæ, so characteristic of the latter, being here quite indistinguishable. The shell of Nautilus is the only one in which the presence of *two* layers is obvious, from their difference of texture. A thin section of the external layer of the shell of *Nautilus Pompilius*, taken parallel to the surface, shows that it is made up of an aggregation of cells of various sizes, those strata which are nearest the surface being the largest. The internal or nacreous layer is also distinctly cellular.

The body of the animal of Nautilus, which is applied to and forms the septum, is of similar smooth and rounded form, and we may reason from analogy that the arborescent lobes of the septum in the fossil Ammonites, were likewise moulded upon a similarly formed body. If we seek a reason for this complication of structure in Ammonites, we shall find a possible explanation in the connecting siphon which, piercing the centres of the septa in Nautilus, enables the animal thereby to strengthen its hold upon its shell; but piercing laterally in Ammonites, gives only an excentric attachment. In the latter case, the lobes and ramifications, applied to the corresponding parts of the animal, would tighten its attachment, and partially remedy the want of the central support.

The outlines of the septa are termed *sutures*, and when these are folded, as in Ammonites, etc., the elevations are called *saddles*, and the depressions, *lobes*. This frilling or folding is found principally at the junction of the septum with the shell-wall, it being nearly flat in the middle, even when its sutural complication is extreme. These parts are subdivided thus: A single *dorsal lobe* surrounds the siphon, and occupies the medial region of the back, and the additional two lobes on either side of it are named the *superior lateral lobes* and *inferior lateral lobes*, whilst other lobes, whatever their number, are called auxiliary lobes; finally, opposed to the *dorsal* is the *ventral lobe*. The saddles bear a corresponding nomenclature, that between the dorsal lobe and the superior lateral, being termed the *dorsal saddle*, the next the *lateral saddle*, etc.

All multilocular cephalopods have the chambers of their shells connected by a siphon, which traverses the septa, and receives from the latter a series of short investing tubes.

The siphon pierces the middle of the septa in Nautilus, in Orthoceratites, etc., whilst it is near the internal edge in Aganides, and the dorsal edge in Goniatites, Ammonites, etc.

It has been supposed by Buckland, that the siphon, which communicates with a large sack, discovered by Owen, in the body of *Nautilus Pompilius*, may constitute a hydraulic apparatus by which the animal may vary the weight of its shell at will by introducing water into it; but the narrow calcareous covering which partially confines this tube, preventing dilatation, militates strongly against this hypothesis. D'Orbigny's guess seems more reasonable, that this tube may not only serve as an attachment, but that it may also assist in the formation of a new septum, by keeping filled with compressed air the vacant space, in the rear of the animal, which is to be divided off. Prof. Keferstein, of Göttingen, supposes, also, that the *Nautilus Pompilius*, in order to raise itself in its shell to the place where it designs constructing a new partition, employs the tension of an aeriform fluid, which it produces from the bottom of its sack, and which presses its body upward. The air disengaged by the Nautilus develops a considerable force, because it conquers not only the resistance of weight of the animal itself, but also that of the weight of about six atmospheres, which presses upon it in its habitual station at the bottom of the sea.

In the Report of the Brit. Assoc. for 1864, Harry Seely says: "On examining a *Nautilus*-shell, two large muscles are seen to have been placed in the lower part of the body-chamber, and connected round the involute spire by a narrow muscle—an arrangement to which the shell may owe its involute form. Beneath the muscles are the liver, which overlaps the spire, the ovaries, which abut on a large part of the septum, and certain digestive organs above these. Before any new chamber can be made, the shell-muscles must have moved forward; and before any increase in the ovaries can take place, a place must be formed behind. As the animal steadily grows, all its organs would enlarge; and, with each successive brood, the distended ovaries would require more space. There is a similar gradual increase in the size of the air-chambers, and, since the development of ova would necessitate a forward growth of the mollusk, the discharge of the ovaries would leave an empty space behind, into which the animal could not retire, which would then be shut off by a septum moulded on the animal's body. In the male *Nautilus*, the testes are placed in exactly the same position as the ovaries of the female, and, excepting the liver, form the largest organ in the body. It may therefore be concluded, that the development of the male organs would produce results similar to those in the other sex; and likewise end in the formation of chambers.

There are no other organs of the body which are liable to periodic changes in size; and therefore, as the position and progressive enlargement with age of the generative apparatus necessitates results like those seen in the chambers and septa, I regard one as the cause of the other."

Prof. Keferstein decidedly agrees with Woodward and others, that the adductor muscles of Nautilus continuously grow forwards, and are re-absorbed behind, rather than suddenly moved as supposed by d'Orbigny. Then if these attachments added to that of the continuous horny girdle suffice to hold the animal to its position, the septum, as Woodward shows, would result from a rest-period, and should at least be externally distinguishable among the growth lines of the exterior surface. In this case, Mr. Seely's theory falls, and the animal simply builds the septa as do the Cones, certain Bulimi, etc.

It is only the backs of the septa which are covered with membrane, and this membrane may be required to maintain the vitality of the shell in the deserted chambers. Keferstein also considers it most likely that the siphon serves to maintain the purity of the air in the chambers. The Nautilus may swim, being provided with a locomotive tube or siphon, but it certainly is not well adapted by its structure for that mode of progression, and probably prefers the sea-bed.* Still, the specific gravity of shell and animal so nearly equals that of the sea-water that probably the additional displacement caused by spreading out to the utmost its tentacles would cause it to rise in the water. It is just possible that when the Nautilus issues from its shell the gas contained in the last chamber in the rear of the animal may expand, and so reduce the specific gravity.

The siphuncle is vascular, it opens into the heart-cavity *(pericardium)*, and is most probably filled with fluid from it.

Woodward says (Man. Moll., p. 184): The use of the air-chambers is to render the whole animal (and shell) of nearly the same specific gravity with the water. Thus a *Nautilus Pom-*

* Mr. A. S. Bickmore, who collected Nautili at Amboina, observes that it has been commonly believed that the Nautilus occasionally rises to the surface, and "setting its sails, floats over the sea." This was first reported by Rumphius, but, after making continued and careful inquiries, he had satisfied himself that there is no reason to suppose that the animal ever rises from the bed of the sea.—*Proc. Bost. Soc.. N.H.*, xii, 157, 1868.

pilius in the cabinet of Mr. Morris weighs 1 lb., and when the siphuncle is secured it floats with a half-pound weight in its aperture. The animal would have displaced two pints or 2·5 lbs. of water, and, therefore, if it weighed 3 lbs., the specific gravity of the animal and shell would scarcely exceed that of salt water. The object of the numerous partitions is not so much to sustain the pressure of the water, as to guard against the collisions to which the shell is exposed. They are most complicated in the Ammonites, whose general form possesses least strength. The complicated sutures perhaps indicate lobed ovaries; they occur in genera which must have produced very small eggs. The purpose of the siphuncle (as suggested by Mr. Searles Wood) is to maintain the vitality of the shell during the long life which these animals certainly enjoyed. Mr. Forbes has suggested that the inner course of Hamites broke off as the outer ones were formed. But this was not the case with the Orthocerata, whose long, straight shells were particularly exposed to danger; in these the preservation of the shell was provided for by the increased size and strength of the siphuncle, and its increased vascularity.

In Endoceras we find the siphuncle thickened by internal deposits, until in some of the very cylindrical species it forms an almost solid axis. It has been stated that the septa are formed periodically; but it must not be supposed that the shell-muscles ever become detached, or that the animal moves the distance of a chamber all at once. It is most likely that the adductors grow only in front, and that a constant waste takes place behind, so that they are always moving forward, except when a new septum is to be formed; the septa indicate periodic rests. The consideration of this fact, that the Nautilus must so frequently have an air-cavity between it and its shell, is alone sufficient to convince us that the chambered cephalopods could not exist in very deep water. They were probably limited to a depth of 20 or 30 fathoms at the utmost.*

The specific gravity of the chambered shells of cephalopods being such as to enable them to float upon the surface of the

* The air-chambers would be crushed by the pressure of water at any considerable depth: this pressure exceeding 265 lbs. to the square inch at 100 fathoms – at which depth, empty bottles, securely corked, are crushed.

water, explains the cause of large quantities of shells of Spirula being washed ashore in localities removed many hundreds of miles from the habitat of the animal; it also explains satisfactorily two interesting palæontological facts, namely, the innumerable quantity of fossil shells found in beds which represent ancient beaches, and their absence from those beds which formed sea-bottoms.

External cephalopodous shells are all symmetrical except the genera Turrilites and Helicoceras; these latter instead of forming a spiral rolled in the same plane, are obliquely spiral; that is, on one side is the projecting spire of the shell, on the other the umbilical opening or axis of the volutions. The symmetrical forms, very numerous, vary all the way from a straight to a coiled growth, their difference in plan of growth constituting the generic distinctions; to be enlarged upon in the descriptive portion of this work. It may be remarked here, however, that in some genera a change of form takes place after they have attained a certain age. In Lituites the shell commences with an open spiral (with disjointed whorls), and finally grows in a straight line. In Ancyloceras the commencement is similar, but after elongating the whorl for awhile the extremity is incurved. And in Scaphites a similar mode of growth to Ancyloceras is distinguished nevertheless by the initial spiral whorls being in contact. All other modifications caused by age, do not change the form but merely the external surface of the shells. Some fossil Nautili, for instance, striated when young, become smooth at a later period, whilst others smooth when young are striated or ribbed when adult.

So in the Ammonites, the juvenile shell is always smooth, but in the course of growth, tubercles, ribs and striæ appear, and develop until the animal has become adult; after this period degeneration takes place, the ornaments gradually disappear in the successive growths, and in old age the surface of the outer whorl may be as smooth as in youth. In Ammonites of the same species two forms of shells may be observed, one much compressed, the other swollen; and it is reasonable to conjecture from analogy with living species that the sexes are thus indicated to us, the swollen shell being required for the ovary of the female.

It will be seen from the above that the study of the species of multilocular shells is encompassed with great difficulties, owing to the variability of their characters; in fact the synonymy of the species of Ammonites has been greatly increased in consequence of several names being given to the same species at different periods of its growth.

The living Nautilus also, undergoes a change of form. At a recent meeting of the Boston Society of Natural History, Prof. Bickmore exhibited fifteen shells of *Nautilus Pompilius*, of various sizes, from one which measured five-sixths of an inch by one inch and one-sixth in its two diameters, to one measuring two and five-sixths inches by three and three-fourths inches in its two diameters. The smaller ones are so loosely coiled that it is possible to look between the coils. These young specimens therefore represent the loosely-coiled Nautiloids of former geological ages; and the *Nautilus Pompilius* at the different stages of its growth is an epitome of the whole group.

The *body chamber* is always very capacious; more than double the size of the combined air-chambers in *Nautilus Pompilius*, it includes in some Ammonites more than an entire whorl of the shell. The margin of the aperture, somewhat sigmoid and simple in Nautilus, has projections or extensions in some fossil species; and in Phragmoceras and Gomphoceras the aperture is even so considerably contracted as to have led to the supposition that the animal was not able to withdraw its head and tentacles within the shell.

In these curious silurian forms M. Barrande thinks that the neck was enclosed in the upper part of the aperture, the lateral lobes giving passage to arms, and the lower lobe to the funnel. But there is reason to believe that the fossil Ammonites possessed a more effective method of closing their aperture; namely a horny or shelly *operculum*. In the Nautilus the union and expansion of the two dorsal arms forms a disk or so-called *hood*, by which the animal may close the aperture of the shell, and in Ammonites (probably secreted by these dorsal arms) there appears to have been a true operculum; at least opercular-shaped bodies of which many species have been described are constantly associated with, and frequently within the body chamber of the Ammonites. The true nature of these shelly or flexible horny plates has not been authoritatively settled however; they have been described under the names of Aptychus and Münsteria as bivalve shells, and have also been thought to be cirripeds and even the cartilages, gizzards or *ventrally placed* cuttle-bones! of Ammonites; but the weight of opinion is decidedly in favor of regarding them as opercula (first suggested by Rüppell, in 1829). In the Arietes group of Ammonites the operculum is a single, horny, flexible piece, whilst in another group it is shelly, consisting of two plates joined by a median suture, the exterior face smooth or striated and the interior marked by growth-lines. It is proper to state that Keferstein (Bronn's Klassen, iii, 1335), after considering the subject at length, concludes that these were not opercula, but does not give a decided opinion as to their function, although admitting their connection with the Ammonites.

The outer layer of the shell has been generally destroyed in fossil Ammonites, etc., leaving only the inner or nacreous and more indestructible layer, which thus exhibits perfectly the edges of the septa; but in some cases it is only the outer layer that has been preserved; and frequently when the whole shell has disappeared, we have perfect *casts* of the chambers. The decomposition of the animal has contributed to form those phosphates and sulphides generally present in the body chamber, whilst the permeation of water deposits crystals of calcareous spar on the inner walls or sometimes even fills the entire chamber. Cross-sections of fossil Ammonites with the chambers filled with spar, when polished, make beautiful cabinet specimens. Sometimes, as in some of the Orthocerata, the circumjacent mud has invaded the air-chambers, but without entirely filling them, because the contraction of the vascular lining has left empty spaces between itself and a portion of the wall of each chamber.

Muscles, Arms and Fins.

In Nautilus we distinguish the two adductor muscles, by which the animal attaches itself to the walls of its shell, and which are united by a horny collar; and within the shell itself we may notice on either side the impressions of these attachments, sunken into the pearly walls. On the outer side of the head-cartilage and its projections towards the siphon is found another important muscle, that of the neck or collar, which resembles the cartilaginous neck-plate of the dibranchiata. Other strong muscles arise from the surface of the two siphon cartilages and form an organ more or less completely tubular—the *siphon*—the important means of conducting the respired water when driven out from between the body and mantle by the contraction of the latter, and serving as a swimming organ also, by the same action, performed with greater vehemence. There are found on either side of the internal shell of the dibranchiates, or in a similar position in the mantle of the shell-less Octopus, upon the continuations of the head-cartilage body-muscles, and there are also important muscles of the mantle by which its lower surface may be compressed forcibly in respiration or natation. In swimming, the aperture of the *funnel* or siphon is normally directed towards the head, and its discharges cause a series of backward rapid motions, but the animal is able at will to direct the stream to either side, and even to bend the anterior end of the siphon back upon itself to some extent, when it desires to vary the direction of its movement. In some genera a valve is developed within the funnel preventing the reflux of the water. The funnel is entire in the dibranchiates, but cleft in its length in the Nautili; upon its base is found, in the decapod genera, a portion of the curious stiffening processes (appareil de résistance) of which we have already spoken. In Onychoteuthis and Ommastrephes, the funnel is lodged in a special cavity in the under side of the head.

The so-called fins or swimming membranes, wanting to nearly all the octopods and the Nautili, exist in all decapods, in their various genera assuming distinctive forms, which may occupy either the whole of the sides of the body or only a portion thereof, and even extend behind into a sort of tail. These membranes in Loligo, Ommastrephes and in Onychoteuthis are formed of transverse muscular layers covered with a very thin epidermis, their surface striated by the muscular fibres beneath. These fins are not contractile, but invariable in form; they are firm and coriaceous, their edges are always entire and very thin. In Sepia the membrane part is covered with a thick skin which extends beyond it. The firmness of the fins seems to be in direct relation to the habitudes of the species; thus the pelagic genera, encountered only on the high seas and possessing the power of darting to some height above the water, are furnished with the most coriaceous fins; whilst those of the littoral genera are of a softer consistence. Whilst the fins are of secondary importance as means of locomotion, they serve additionally as a parachute to preserve the position of the body in the water, and to vary the same according to the desire of the animal; their rapid undulation, commencing from the front or hind part, according to the direction in which the animal wishes to progress, is of course, of considerable aid in navigation.

The Arms are at once organs of locomotion, either by swimming or crawling, of touch and of prehension. In the tetrabranchiates they are multiplied in number but reduced in size and strength, being short, cylindrical, without cupules or sucking disks, and retractile into two series of distinct sacks; in the dibranchiates they are of definite number, namely *eight* sessile or non-retractile arms; with the addition of two, generally much longer, contractile, tentacular arms in some of the genera; and these are all provided with suckers or organs of prehension.

The arms of the octopods are longer, more fleshy and altogether better adapted to their creeping locomotion, and to reaching out from their rocky hiding-places to seize the passing prey; whilst the comparatively shorter arms of the decapods are compensated by the two, generally very large, retractile *tentacles*, the swimming membrane, the more cylindrical narrow body, and the stiffening of the cuttle-bone or pen, in adapting them for their pelagic life.

The internal face of the arms is provided with sucking disks or cups intended to retain objects with which they may be brought in contact. The cups are sessile and fleshy only in the octopods, and they are pedunculated and then furnished with an internal corneous ring, armed with a serrated edge or with a corneous hook in the decapods.

In Eledone and Cirroteuthis the sessile cupules occupy a single median line on the arms, whilst in the other octopod genera they are in two parallel lines. In Octopus they are infundibuliform, shallow, with a depressed radiated surface. In Argonauta these cups are slightly narrowed at their base, and in

Philonexis (Tremoctopus) they are cylindrical and extensible. The sessile suckers are powerful means of prehension; they act like cupping-glasses by the withdrawal of a central plug.

The pedunculated cupules of the decapods occupy alternately, two lines in all the genera except Sepia, in which they are in four lines. Always very oblique, raised on a narrow excentric stalk, they are fleshy, marked externally by a thin margin which confines a corneous ring, in the middle of which is an elevated surface. The functions of these cupules compared to those of the octopods appear to differ in this respect, that they cannot hold by suction, being prevented by the thin border and corneous ring, but in lieu of this means of prehension they have the ring itself powerfully armed with *recurved* points, and greater facilities of attachment on account of having the cupules pedunculated and movable, instead of sessile as in the octopods. In a state of repose these formidable rings are covered by their fleshy borders, which are only contracted when their weapons are to be used.

Whilst the corneous circle or ring exists in all decapods, it is modified nevertheless in the different genera, as will be shown in the systematic portion of this work. Enoploteuthis, and the fossil Belemnites offer a curious modification of structure of the corneous ring, which has disappeared apparently, and is replaced by powerful recurved hooks, which are really the two sides of the circle applied closely together. These hooks are retractile or extensible at the will of the animal, and when retracted are totally enveloped with flesh—resembling the velvet cushion of the paw of a cat.

The tentacular arms or tentacles of the decapods, always arising from sub-ocular sacks in the circle of sessile arms and between the third and fourth pairs of the latter, are entirely retractile in Sepia, in Sepiola and in Rossia, but only partially so in other genera. Very long (in Chiroteuthis six times the length of the body), they consist of a rounded or compressed stalk, generally without cupules, and an expanded and thickened extremity or *club*, armed with cupules upon its internal face. These cupules or hooks are very unequal in size and occupy four lines upon the club in Loligo and Ommastrephes, six in Histioteuthis and six or ten in Sepia, Sepiola and Rossia. Onychoteuthis, Enoploteuthis, Celæno and Belemnites have hooks, in two rows; and in the two former there is additionally a group of small cupules and tubercles at the base which may be used to form by the apposition of these parts in the two tentacles a sort of fleshy articulation and support for the action of the armed clubs. Chiroteuthis has an additional oval fleshy cupule at the extremity of the club.

The web which connects the arms in many of the cephalopods may be likened to an *umbrella* of which the arms themselves may represent the ribs. It is but little developed in some genera, but attains an enormous development in Cirroteuthis, where it unites all the arms to nearly their tips; and in species of Tremoctopus it is only developed between the dorsal or superior arms.

The modification of one of the sessile arms of the male Cephalopods for sexual purposes, causing it to assume a totally different appearance, will be more appropriately treated under *sexual organs*.

In the tetrabranchiates, of which the Nautilus is an example, the foot is represented by a *sheath*, in the margin of which are digitations, eight in number, and from these digitations project in a double series, thirty-six small unarmed brachial tentacles, lamellated on their inner surface, and retractile at the will of the animal. This sheath expands greatly dorsally, forming a triangular, tuberculate, fleshy hood, by which the aperture of the shell may be closed in lieu of an operculum. In addition to the brachial there are other tentacles; namely four groups of twelve or thirteen each, termed *labial*, and surrounding the lips, and four *ocular* tentacles, situated one in front and one behind each eye, and which appear to be organs of sensation. In the male there is some modification; the internal tentaculiferous lobes are wanting, and the external ones are divided into an anterior with eight and a posterior one with four tentacula. Upon the left side, moreover, the four posterior tentacles are modified into a peculiar hectocotyle termed a *spadix*, bearing a discoidal follicular gland upon its outer surface.

Digestive Organs.

The organs of manducation are composed in the cephalopods of a beak in the form of two corneous or calcareous mandibles, and resembling that of a parrot, within which is a fleshy tongue armed with teeth. These parts are enveloped in a large muscular bulb which supplies the force to the jaws. External to the beak are two lips, themselves surrounded and protected by an extensible buccal membrane, situated between the buccal bulb and the bases of the arms. Whilst the buccal membrane is wanting to the octopods, it is well marked on the contrary in the decapods. In development it forms a vast funnel, and in repose it covers all the exterior part of the mouth. It is encircled by eight or ten fleshy appendages, externally marked by as many muscular ridges which correspond to the bands connected with the arms. The buccal membrane, doubtless assists in retaining the food of the animal in juxtaposition with the mandibles, and for this purpose the fleshy appendages are provided at their internal extremity in the Calamaries and in Sepioteuthis with cupules similar to those found on the arms.

The lips, of which the external one is thin, always short and with entire border, and the internal, in contact with the beak, thickened, fleshy and papillary or ciliated upon its edge, can be contracted over the beak, so as to cover it entirely, fulfilling functions analogous to the lips in mammalia.

The beak is corneous; with a more or less calcareous investment in the tetrabranchiates. It differs from the beak of birds in that the superior mandible instead of covering the inferior, shuts within it. The superior mandible is composed of two distinct parts, the one rostral, more or less arcuated, sharp in front, forming behind a hood separated by an inferior expansion varying in length or breadth according to the genus. The inferior mandible, always larger, has a less sharp rostrum, and is also composed of a rostral portion and an inferior expansion; but with this difference, that the lateral part is elongated on each side and forms a wing, varying in form.

Calcareous in Nautilus, Rhynchoteuthis and Paleoteuthis, the beak is infinitely larger, without hood in Paleoteuthis, whilst along with the hood there are wide calcareous wings in Rhyncoteuthis. In the corneous-beaked species the superior mandible has a very short rostral portion but little separated from the expansion in Octopus; still but little separated but wider in the Argonauts and Philonexis (Tremoctopus); very long, but little separated in the Calamaries, in Sepia and Sepiola; less long but well separated in Ommastrephes; but little separated in Onychoteuthis, in Loligopsis and in Histioteuthis, which at the same time have a much longer, more curved and sharper rostrum. The posterior expansion is short, composed of three equal lobes in the Argonauts and Tremoctopus, very long and with only an indication of a lobe in Octopus, and without lobes in Sepia, the Calamaries, Rossia and all other cephalopods.

The rostral part of the inferior mandible is rounded behind in all the octopods, slanting in the decapods. The wings are short, wide in Argonauta and Tremoctopus; very long, narrow and arcuated in Octopus; long, straight and wide in Sepia, etc.; short in Onychoteuthis and Ommastrephes. The posterior expansion is wide, not carinated above in Argonauta and Tremoctopus; very long, narrow, carinated in Octopus; moderately long, wide, carinated above, more sloped in Sepia, Sepiola and the Calamaries; very short much carinated, strongly sloped behind in Onychoteuthis, Ommastrephes, etc.

Under the tongue is found a fleshy mass covered with papillæ, which is supposed to be the organ of taste; and in Nautilus we find similar papillæ on the tongue (behind the teeth), to its entrance into the gullet.

The fleshy tongue is armed above with rows of recurved, spinous teeth, the arrangement of which differs in the various genera. Ordinarily, as in the dibranchiates, we find the series of teeth to consist each of a central one with three side-teeth on either side of it, and sometimes, as in Eledone and Loligo, an additional plate on either side; but in Nautilus we find a modification, in five somewhat quadrangular central teeth of which the middle one has the most pointed end, and on either side two long fangs with a much smaller plate at the base of each—in all thirteen teeth in a series. The central teeth, which are simple in Sepia and Sepiola, are tricuspid in Loligo and denticulated in Eledone; whilst the lateral *uncini* are usually claw-like. Fifty rows of teeth may be found on the tongue of the Sepia; their continuous growth compensates the loss by abrasion.

(Plates 5 and 6 exhibit the teeth of various cephalopods.)

The rounded, sack-like stomach which is situated towards the middle or end of the body is connected with the mouth by a long central gullet; and the intestine, more or less bent upon itself ends in a medial, ventral anus.

One or two pairs of salivary glands are present in the dibranchiates, but wanting in Nautilus. The liver is always large; and the two hepatic ducts are generally glandular. A large and sometimes spirally-wound cæcum is frequently developed from the commencement of the intestine, with which the hepatic ducts communicate. The product of the salivary glands is uncolored, limpid and acid, whilst that of the liver and pancreas is also uncolored and acid, but rarely limpid.

In the tetrabranchiata and the decapoda the œsophagus is dilated into a crop separated from the stomach by a constriction. The cæcum is small and rounded, and the intestine is twice bent upon itself. The four-lobed loosely racemose liver is lodged in the anterior portion of the perivisceral cavity, and is largely developed. From either side of it spring biliary ducts which open in the large blind-sack; the pancreas is found at their commencement.

Nervous System.

The Nervous System is mainly identical with that of the gasteropods. There are the three typical pairs, the cerebral, pedal and visceral ganglia, surrounding the gullet and connected by commissures; whilst the nerves which supply the buccal mass, the alimentary canal, the heart, the branchiæ and the mantle develop additional local ganglia.

The dibranchiates have the principal ganglia so closely connected that the commissures are not readily perceived. The optic nerves are well developed. The superior and inferior buccal ganglia have each united in one mass, and the two are united by commissures around the œsophagus. The large nerves of the arms, and those of the funnel or siphon, proceed from the pedal ganglia, which are placed on the posterior side of the gullet; with them are connected also the auditory nerves. From the parieto-splanchnic or visceral ganglia proceed nerves along the shell-muscles to the anterior wall of the mantle, where they enter the large *ganglia stellata;* these are connected by commissures, and send strong cords to the fins. Branches of the parieto-splanchnic ganglia, following the vena-cava, supply the breathing and reproductive organs. A recurrent nerve from the inferior buccal ganglion follows the œsophagus, ending in a ganglion upon the stomach.

A modification of this plan is found in the Nautili. Here a thick transverse cord situated in front of the œsophagus represents the cerebral ganglia; from its outer angles the optic and olfactory nerves proceed, from its anterior edge those of the buccal mass. The pedal ganglia placed close to the cerebral ganglia, are united by a slender commissure; from them are supplied all the nerves of the foot or arms, of the funnel and of the ears. The parieto-splanchnic ganglia, lengthened into a thick cord, united at each end with the cerebral ganglia, form an œsophageal ring. Two large ganglia are found, one on either side of the stomach.

Organs of Sense.

We have already, in speaking of the digestive system, shown the probable situation of organs of taste; it remains to us to pass in review briefly those of Sight, of Hearing and of Smell.

A. *Organs of Sight.*—The sessile eye is lodged in orbital cavities on either side of the head, in the dibranchiates; in the tetrabranchiates it is elevated upon peduncles. In the former case the cephalic cartilage, as we have already seen, partly encloses it, whilst in some instances special orbital cartilages are also present; the enclosure is completed by a fibrous capsule continuous with the cephalic cartilage, which becomes transparent over the eye and is likened to the cornea or even to the eyelid in vertebrates. This transparent capsule presents several modifications; it may be entire or with a small perforation as in the Octopods, in Sepia, Loligo and other genera, constituting the division *Myopsidæ* of d'Orbigny; or it may have a wide opening, for the projection of the crystalline lens, as in Ommastrephes, Loligopsis, etc.—the *Oigopsidæ* of d'Orbigny. It is entirely wanting in Nautilus.

We find in the dibranchiates a large portion of the eye-chamber occupied by the optic ganglion, by ocular muscles and by a white glandular substance. The silvery *tapetum* lines but does not adhere to the ocular capsule; its two layers pass into one another at the edges of its free prolongation, which forms the *iris*, and between these two layers occur longitudinal muscular fibres. A layer of cartilage underlying the tapetum, forms the *inner ocular capsule*, which extends externally as far as the iris, and is penetrated on its inner side by the fibres of the optic nerve. The *ciliary body* is formed of connective tissue with muscular fibres and is placed, as a thick rim, upon the free edge of the inner capsule. The *lens* is composed of layers of structureless membrane, which are cuticular productions of the ciliary body; it is almost cylindrically elongated in the direction of the axis of the eye. The vitreous humor is a transparent fluid. The *retina*, lining the inner capsule, has an outer and an inner stratum, separated by a pigment layer. The inner stratum is composed of prismatic or cylindrical rods, the inner ends of which, turned towards the ocular cavity, are covered by a membrane; the outer stratum is filled with the plexus of the optic nerve-fibres and with glanglionic cells, connected by tissue; thus the nerve terminations must penetrate the pigment lying between the two strata of the retina in order to reach the rods in the inner stratum.

The pedunculated eye of the Nautilus is much simplified in its structure, having neither cornea, lens nor vitreous humor. The creeping habits of the animal, the abundant protection afforded by its external shell, its want of offensive armor upon the tentacles are here found correlative with a degradation of the visual organ.

A great difference in the size of the eyes in the pelagic and littoral genera accompanies the difference of habit. The littoral Octopus, always existing where the light of the sun penetrates with more or less power, has small eyes, whilst they are enormous in those genera which inhabit the high seas, penetrating to great depths, and which are evidently nocturnal in their habits. So also we find the situation of the eyes to differ according to the habits of the cephalopods: thus the shore species, especially the creepers, have their eyes placed laterally on the back of the head, that they may look above and around, but not below them, whilst the swimmers on the contrary have their large eyes placed directly on the sides of the head to give them equal visual powers in all directions. The eyes in the octopods are fixed, without movement, whilst in the decapods they are free and capable of movement: in the former the skin is susceptible of contraction so as to cover the eye entirely, fulfilling the functions of an eyelid; whilst in the latter the littoral species are furnished with this protection, but the pelagic ones are without it.

B. *Auditory Organs.*—In the dibranchiates the auditory sacks are lodged in cavities of the cephalic cartilage: they each contain a single, large, calcareous otolite. In the Nautilus, however, these sacks are found attached to the pedal ganglia, and contain numerous otolites. The external ears are hollow, plicated processes on the side of the eyes, communicating through a passage lined by a glandular membrane, with the auditory sacks.

C. *Olfactory Organs.*—Kölliker has made the interesting discovery that a pair of pits or papillæ, as the case may be, situated behind or above the eye, are olfactory organs. They are pits above the eyes in the Teuthidæ and Sepiadæ and in some of the Octopods, but in Argonauta and Tremoctopus they are developed as papillæ, and in Nautilus are elongated like small tentacles, placed immediately behind the eyes. D'Orbigny has mistaken them for external ears.

Organs of Respiration, Circulation and Secretion.

The heart, which is placed on the hæmal side of the intestine, receives the blood through contractile vessels connecting it with, and equal in number to the branchiæ; these may be regarded as auricles. The branchiæ are not ciliated, and are generally if not always themselves contractile. The arteries end in an extensively developed capillary system, but the venous channels retain to some extent the character of sinuses. In returning to the heart, the venous blood is gathered into the *vena cava*, a large longitudinal sinus, which is situated on the posterior side of the body close to the anterior wall of the branchial chamber, and divides into a number of branchial vessels corresponding with the number of branchiæ. Each of these vessels traverses a chamber in communication with the mantle cavity (and which may be considered a renal organ), and that portion which comes in contact with the water in the chamber becomes sack-like and glandular. The pericardium and the sacks containing the testes and ovaries, appear to communicate with the pallial cavity either through these chambers or directly.

The blood is a white liquid with a slight tendency to bluish, and contains water 89 per centum, Albumen 3 per centum, Salts and substances incoagulable by heat 7·5 per centum, Fibrine, etc., ·5 per centum.

Valenciennes discovered in Nautilus three pairs of openings connecting the branchial sack with five chambers; of which the anterior and posterior pairs situated on the sides of the rectum are each provided with a single opening; whilst the fifth, a much larger chamber, has an opening on either side. It is separated by their walls from the other chambers; and from the afferen branchial veins which traverse these walls, lamellar appendages project into the paired chambers, and papillated ones into the single large chamber. In the smaller chambers are usually found concretions of phosphate of lime, without trace of uric acid.

The gills form a cylinder in Octopus and Sepia, and in Loligo and other genera they are in the form of a half-cylinder: they are two in number in the naked cephalopods, as well as those possessing an internal shell; and four, arranged a pair on each side, in the Nautilus: hence the terms Dibranchiata and Tetrabranchiata, forming the highest divisions of the class Cephalopoda. The water finds access to the gills through the large opening between the free anterior ventral margin of the mantle and the body, and it is expelled from the funnel by a muscular contraction of the wall of the mantle.

The mantle is usually fastened dorsally by a muscular neck-band or *nuchal* band, to the head of the animal, and this band may be either narrow or broad, or may even extend laterally nearly around to the siphon: but usually the ventral margin of the mantle, at least, is detached from the body: the degree of attachment varies in the different genera. Within the mantle opening are found the branchiæ, the anus, the openings of the generative and urinating organs, and of the ink-bag.

Urinary openings are found on each side of the rectum. The urine is decidedly acid and limpid, and is filled with myriads of infusoria and a great quantity of aggregations of little crystals of a fine red color, and rhombohedral or rhomboido-lamellar in form, giving the reactions of uric acid.

The ink-bag (not present in Nautilus) is a tough and fibrous sack, the outer coat of which is thin and silvery; the contents are discharged by a duct direct (or, as in most decapods, through the anus) into the mantle opening, and thence diffused in the surrounding water; covering the movements of the animal by the obscurity in which it becomes almost instantly enveloped. There can be no doubt of the use of this organ in facilitating escape from danger. The ink itself was formerly used by the Chinese in the preparation of Sepia or India Ink, but this substance is now made from lampblack. In Italy and in Turkey the Sepia is still prepared from the dried pigment of the cuttle-fish, which is browned by the action of an alkali.* So indestructible is the ink, that it is frequently met with preserved with the fossil remains of Belemnites and other extinct genera. The full protection afforded the soft parts by the external shell of the tetrabranchiates accounts for the absence of the ink-bag in that division of the cephalopoda.

An analysis of Sepia shows that 78 per centum is composed of the black coloring matter (the Melania of Bizio), and that of the residuum there is 10 per centum carbonate of lime, 7 per centum carbonate of magnesia, and sulphate and chloride of soda 2 per centum.

Mr. Lloyd states, in his interesting "Handbook to the Marine Aquarium," "that the ink (which is viscid) does not generally become diffused through the water as writing-ink would be, but is suspended in the water in a kind of compact cloud till it gradually settles down, and is dispersed in flakes." Now I quite think, with Mr. Lloyd, that this being the case, it is difficult to perceive how, according to the generally received opinion, the retreat of the animal is covered by the ejected cloud. It seems to me more likely that this discharge is to divert the attention of a pursuer—a dog-fish for instance—which would for the moment

* The method of preparing Sepia practised on the shores of the Mediterranean, is to carefully extract the ink-bag and dry its contents Triturated with caustic soda or potash, it is afterwards boiled for half an hour with caustic lye, and finally the liquid is treated with an acid until neutralized. After standing, a precipitate falls, which is collected and dried by a mild heat, and forms the Sepia of commerce.

be startled by the sudden appearance of masses of dark color in the water, and in the confusion the cuttle makes his escape.—W. R. HUGHES, in *Nature*, ix, 363, 1874.

Dorsal aquiferous pores are found opening upon the head in Argonauta and Tremoctopus: they communicate with large internal cavities. In Ommastrephes and Tremoctopus anal pores, with small cavities, are found on each side of the siphon; in Onychoteuthis they are placed in advance of it; in other genera they are wanting. The buccal region in Histioteuthis and Ommastrephes has four aquiferous pores, and there are six of them in Onychoteuthis, in Sepia and in Loligo: the other genera want them. Finally, there are brachial pores situated near the bases of the tentacular arms and between the third and fourth pairs of sessile arms: in Sepia, Sepiola and Rossia they communicate with the great cavities in which are lodged the tentacles when contracted; in Loligo the smaller cavity only suffices to lodge a portion of the tentacula, and in Histioteuthis, Ommastrephes and Onychoteuthis the cavity is still more restricted, and only occupies a part of the head anterior to the eyes: wanting in other genera. These pores are probably lubricative in function.

Sexual Organs.

The sexes are distinct in the cephalopoda and in some of the genera at least, the female individual is the largest and readily distinguishable externally. The reproductive organs are lamellar or branched; their cellular contents are metamorphosed into ova or spermatozoa, which are attached to the wall of a chamber communicating with the pallial cavity by one or two ducts, which, in the female present glandular enlargements. Upon the walls of the branchial cavity of the female two nidimental glands are developed; besides, sometimes accessory glands, within which is secreted a viscid fluid which envelops the ova and aggregates them into various forms, differing according to the genus.

In the male the cases or spermatophores containing the spermatozoa are furnished by a prostatic gland. These spermatophores, in the dibranchiata are ovate, cylindrical and narrow, consisting of a thin case, ending sometimes in a filament at one end; at the other or thicker end is contained a sack full of spermatozoa, to which is attached an elastic spiral cord, coiled and compressed within the balance of the case. Upon coming in contact with the water these spiral bodies commence moving and finally burst through the thin end of the investing spermatophores dragging with them their sacks of spermatozoa.

In Nautilus, Van der Hoeven has ascertained that the structure of the spermatophores is much more simple. In this genus the oviduct arises from a chamber which communicates with that in which the ovary is lodged. A large albumen gland opens into the latter. So also the *vas deferens*, instead of originating directly from the sack of the testes, communicates with it through an intervening chamber.

The sexes in *Sepia officinalis* may be readily externally distinguished. There is in the first place a difference of coloration, the females being unicolored, whilst the males have zebra-like markings across the marginal fins and the dorsal arms—especially when irritated. But the best means of distinction is in the relative lengths of head with the arms, and body; in the males these two dimensions are about equal, but in the females the body is only two-thirds the length of the head and arms. The cuttle-bone in the female is much wider and more excavated behind.—Bert, *Mem. Linn. Soc. Bordeaux*, v. 118.

The most curious portion of the sexual history of the cephalopoda is undoubtedly that which relates to their sexual union, which is accomplished through the offices of one of the arms of the male, which becomes modified in its structure for this purpose. This arm, very unlike the others in appearance, sometimes becomes detached from the animal during the sexual union, and remains within the mantle of the female for a period, during which it enjoys a separate life. Each genus seems to be characterized, not only by the particular arm, either on the right or left side of the animal which is thus *hectocotylized* but also by differences in its appearance and structure. The third left-side arm of the Argonaut is first developed as a balloon-shaped sack, which finally splits open and reunites its halves upon the dorsal face of the arm which emerges from it, forming a chamber which becomes filled with spermatophores, in a manner not yet understood. Indeed the investigation of this whole subject may be considered as yet in its infancy, and many points remain to be cleared up: thus in some genera no sack for the reception of spermatophores has been found, and the hectocotylized arm appears to perform its office without subsequent detachment from the animal. The detached hectocotyle when first discovered in the mantle of the female was naturally regarded as a parasitic worm: that of Argonauta being termed *Trichocephalus acetabularis* by Chiaje and that of Octopus *Hectocotylus octopodis* by Cuvier. More recently it was supposed to be the entire male animal of the cephalopod.

In Tremoctopus the third arm on the right side becomes hectocotylized; it is then worm-like in appearance, with two rows of suckers on its ventral surface and an oval appendage at the posterior end. The anterior part of the back is fringed with a double series of branchial filaments (250 on each side). Between the filaments are two rows of brown or violet spots. The suckers (forty on each side) closely resemble, but are much smaller than those of the normal arms. Between the suckers are four or five series of pores, the openings of minute canals passing into the interior. There is an artery and vein on each side, giving branches to the branchial filaments, while a nerve runs down the centre. The *oval sack* encloses a small but very long convoluted tube, ending in a muscular sack which contains the spermatozoa.

The hectocotyle of the Argonaut is very small, only half an inch, with a filiform appendage in front of about equal length; it has two rows of alternate suckers, forty-five on either side; but no branchiæ.

The Father of Natural History, who was certainly a first-class observer, was acquainted with the hectocotylized arm and its functions, but his degenerate successors for many centuries not only misunderstood *it* but *him* also.

In Octopus the hectocotylized arm instead of being much shorter than the others, as in Argonauta, becomes much longer. It terminates in an oval plate, marked with numerous transverse ridges and intervening pits, and this is connected by a muscular fold of skin running along the dorsal face of the arm with the webbed base, covering a passage through which the spermatophores are probably transmitted to the terminal plate.

It will be seen in the systematic portion of this work that able observers have in some cases regarded as opposite sexes only quite distinct forms of cephalopods, described as different species; this investigation is yet in its infancy, but will not improbably result in a considerable reduction of the species, many of which are already known to be insufficiently characterized.

The specialization of an arm for reproductive purposes in the cephalopoda is curiously paralleled in the arachnida, as in some species of spiders certain parts of the palpi of the males are transformed for the same purpose into spoon-shaped organs. As to the loss of the hectocotylized arm, which at least occurs usually in some genera, as *four* of them have been discovered in the mantle opening of a single female Octopus, there is no doubt that another arm is developed to take its place, and it is probable that these succeeding arms may be hectocotylized like the first.

We have already shown that in the male Nautilus the four inner ventral tentacles become united into a so-called *Spadix*, which is now believed to perform in the tetrabranchiates the office of a hectocotyle.

M. Steenstrup observes that it is evident this peculiar structure, sometimes of one pair of arms, sometimes of another, sometimes to the right, sometimes to the left, sometimes at the summit, sometimes at the base, etc., must involve many differences in the mode of fixation of the spermatic masses or spermatophores on the females, and (inasmuch as the semen does not seem to be poured upon the eggs by involuntary or mechanical, but by conscious movements) in the manner in which fecundation is effected. This is confirmed by observation. The spermatic masses are in reality fixed on very different places and in very different conditions—namely, in the genera Sepia, Sepioteuthis and Loligo (consequently all those in which he has found the left ventral arm hectocotylized) the spermatic mass is fixed on the internal surface of the buccal membrane of the females, which is specially organized for that purpose; whilst in the other decapoda he has never found the sperms fixed in that place, but on various parts of the mantle or of the interior organs, in Ommastrephes, for example, far back in the cavity of the mantle, towards the middle part of the back.

The buccal parts of a female of *Sepia tuberculata* of the Cape, present the following peculiarity: the male has fixed the whole mass of the spermatophores on the *external* surface of the buccal membrane—a thing which he has never seen in any other Sepia, although he has sometimes observed that a few spermatophores had separated from the others and fixed on the external surface, nay, even near the base of the arms.—STEENSTRUP, *Comptes Rendus*, 567, 1875; *Ann. Mag. N. Hist.*, 4 ser., xvii, 93, 1876.

Dr. Bert, in the course of his researches upon the physiology of Sepia, remarked two individuals in coitu, and upon separating them discovered that the hectocotylized arm of the male was thrust within its own mantle opening, instead of, as he expected, that of the female. Is it not possible that in some genera at least, of the decapods, the want of a covered passage through the hectocotylized arm for the transmission of the spermatophores, is remedied by the mechanical action of the arm itself in transmitting them from the mantle pouch and fixing them to the interior face of the buccal membrane of the female, where they may remain until by their bursting (perhaps assisted by compression of the membrane) the innumerable sperms are diffused through the water, and thus gain access to and fertilize the ova. I put this forward with some hesitation, as a theory which may derive some support by the consideration of the difference in habit between the swimming and creeping species, which in the former may sometimes render the sexual embrace more difficult than in the latter.

Lafont, who has studied at length the fecundation of various species of cephalopods in the aquarium of Arcachon, had (in 1868) in only a single instance noticed the spermatophores placed externally upon the female, and that was under extraordinary circumstances; the individuals belonged to different species of Sepia, and the opposition of the female to the sexual union was manifest, and resulted in the infliction of injuries from which both died. He thinks that the mode of fecundation known as hectocotylization in Argonauta and Tremoctopus, is not very positively practised in Sepia and Ommastrephes, nor very probably in Loligo and Octopus; and he concludes that it is certain (from his observation) that in the genus Sepia the bundles of spermatophores disperse their contents in the branchial cavity of the male during the sexual union, and that the compact cylinders of sperms thus dispersed pass into the branchial cavity of the female, where they slowly disaggregate. The male, after having enlaced his arms with those of the female, bringing together their ventral surfaces, expels the spermatozoa, rolled into a pellet through its siphon along with the respired water, and they then enter the branchial cavity of the female, along with the current of inspiration. The arms remaining interlaced during the entire period of accouplement, do not appear to play any other rôle during this act.

Lafont has sometimes seen the male Sepia, when sexually excited, insert his arms of the third and fourth pairs on the left side into his left branchial opening, whence they are withdrawn after some minutes, but without bearing any spermatophores upon them; nor with any other indication of the reason of this movement. See, for very interesting and detailed observations on this subject, Lafont's memoir, in *Annales des Sc. Nat.*, 5 ser., xi, 1869.

In the "Actes de la Société Linnéenne," of Bordeaux, 1872, M. Lafont continues an account of his observations. He states that a *Sepia Filliouxi* deposited its eggs in one of the basins of Arcachon, on the 23d of May, 1870, attaching them to a Zostera. Taking it from the water, he found all around the mouth, attached by the large end, a certain number of little sacs filled with spermatozoa. Replaced in the water, the animal continued to oviposit. In again examining it, at the end of about a half-hour, he saw that the number of sperm-sacks had diminished, not more than a dozen remaining. As soon as again put in the water, a male approached and a sexual union took place. He immediately examined the female again, and found the mouth surrounded by spermatophores attached to the buccal membrane. After this examination, the animal was permitted to continue ovipositing, which she did for more than two hours. It is evident, says M. Lafont, that these spermatophores serve to fecundate the eggs at the moment when they pass out of the siphon and when the female takes them between her arms. Since that period more than half of the females of Sepiæ and nearly all those of Loligo that he has examined, were found to carry a greater or less quantity of spermatophores around their mouth.

Steenstrup has shown (*Ann. Mag. Nat. Hist.*, 2 ser., xx, 1857) that whilst the octopods (which *alone* are known to lose their copulatory arm) possess in the highest degree the power to reproduce mutilated members; the decapods, on the contrary, are not able to remedy such losses by a new growth; and this is another cogent reason for believing that the process of fecundation is entirely different in the two groups. Steenstrup states that the hectocotylized arms, so far as he can ascertain, present no changes at the season of copulation, that they present the same features in small as in large individuals; and he assumes that when the young male leaves the egg it is already furnished with the hectocotylized arm proper to its species.

Braun has supposed the aptychi to be the shells of the males of Ammonites, instead of opercula; this would explain why they are so often found at the base of the first chamber of Ammonites.

It is also possible that the fragment of a mollusk found by Quoy and Gaimard at the Celebes Islands (*Ann. Sc. Nat.*, xx, 470, 1830) may be the Hectocotylus of the long-sought male of *Nautilus pompilius.*

M. Ussow observes that the spawning time of Argonauta lasts from May to August; of Loligo, Sepiola and Ommastrephes, from March to June; but he has obtained mature ova of Sepia in Naples almost all the year round, except in August.—Ussow, "Development of Cephalopoda," *Ann. Mag. N. H.*, 4 ser., xv, 1875.

I have figured a few forms of egg-clusters (Pl. 19, 20, 22); unfortunately the eggs of the Nautilus are not known, so that our knowledge is confined to the dibranchiates. Of these the most curious is the Argonaut, the elegant shelly structure of which originates from the expanded dorsal arms of the female which cover its sides and form the only attachment of the animal to it. In the unoccupied hollow of the spire are attached the minute clustered eggs, and its special function appears to be for their protection during development. Each egg is separately enclosed in a rounded shell, which is furnished with a long, thin membrane of attachment. We know but little of the eggs of Octopus: Aristotle describes them as similar to those of Argonauta, and attached within shells or similar concave surfaces I figure a group of the eggs of *Octopus punctatus* of Gabb, from San Diego, Cal. Each lengthened, oblong, transparent and colorless egg is attached separately to a stalk, and twenty-five may be found in a cluster: their size is represented by the figure. I have also figured a pair of lengthened cylindrical bodies, similarly attached, and one-celled, collected by one of the Godeffroy Expeditions at the Samoan Islands. These are labeled Egg-Cases of Octopus, but they are probably those of a Sepioteuthis.

In Sepia each egg is enveloped in a large, spindle-formed black capsule, many of which, forming a close mass, are attached to some marine body.

Another form of egg-masses is that in which a number of eggs are contained in a single large capsule (of which many are aggregated into a mass), attached by its pedicel to some submarine object. In *Loligo vulgaris*, for example, each long bag-like capsule contains thirty to forty eggs. The capsule of Sepioteuthis is similar, but shorter, and contains fewer eggs.

During the summer of 1876 I resided at Atlantic City, on the New Jersey coast, and then enjoyed frequent opportunities for observing the development of *Loligo punctata* De Kay; masses of egg-capsules of this species being thrown upon the beach in considerable quantity throughout the season. Some of these masses, when the embryos had attained considerable growth, had grown to prodigious size and weight, being several times larger than of the animal which deposited them. I have seen hundreds of cylindrical cases, each 3 to 4 inches long and half an inch in diameter, composing a single, soft, jelly-like mass, which lay quivering on the beach, reflecting from its glistening surface rainbow hues, and filled with almost innumerable, rapidly pulsating embryos; say at least 250 to each sack. The details of their form and the colored spots of their body were distinctly visible to the naked eye. Each embryo is enclosed in its separate round, transparent egg-case, and during its development the yolk-bag is attached to its mouth, and surrounded by its arms.

Cuthbert Collingwood (*Jour. Linn. Soc.*, xi, 1873), encountered (in 1870), floating upon the surface of the Atlantic Ocean, in lat. 37° N. and long. 28° W., a gelatinous object, somewhat cylindrical in form, about 2 feet long and 4 or 5 inches in diameter, and containing cephalopodous ova arranged in clusters and single rows. The young animals were very active, and in fact were all discharged a short time after the nidus had been secured. It is impossible to ascertain positively at present to which genus this curious form belongs, though evidently the animal is finned and pelagic. The whole oviposit is here united within a single gelatinous covering instead of being aggregated into sausage-shaped masses each filled with embryos as in Loligo, or in separate eggs as in Sepia. I give a figure of one of these ova, magnified 24 diameters. A similar floating mass was obtained by Dr. H. Grenacher, at the Cape Verd Islands, in January, 1872; it was nearly 2·5 feet long by 6 inches in diameter. I give figures both of nidus and embryo, extracted from his elaborate and valuable paper on the development of this interesting form (*Zeit. Wiss. Zool.*, xxiv, 1874).

Quoy and Gaimard (*Ann. Sc. Nat.*, xx, 1830) discovered near the Moluccas, a cylindrical nidimental mass, 3 feet long and 6 to 8 inches diameter, composed of cephalopodous eggs placed in double rows on a ribbon, the circumvolutions of which, with margins overlapping, formed the cylindrical shape. I figure this mass, as well as a portion of the ribbon, showing the disposition of the eggs, as well as one of the latter, magnified. The ribbon does not materially differ from the small portion discovered by d'Orbigny in *Octopus membranaceus*, and which he has erroneously figured as a portion of the nidus of that animal (see my Fig. 6, Pl. 20).

Development of the Cephalopoda.

"In the dibranchiates the yolk undergoes partial division, and the blastoderm (yolk sac) formed upon face of it by the smaller blastomeres, spreads gradually over the whole ovum, enclosing the larger and more slowly dividing blastomeres. The mantle makes its appearance as an elevated patch in the centre of the blastoderm, whilst the future arms appear as symmetrically disposed elevations of the periphery, on each side of the mantle. Between these and the edge of the mantle, two longitudinal ridges mark the rudiments of the epipodia, while the mouth appears in the middle line in front of the mantle, and the anus, with the rudiments of the gills, behind it. The rest of the blastoderm forms the walls of a vitelline sack, enclosing the larger blastomeres.

"The pallial surface now gradually becomes more and more convex, the posterior margin of the mantle growing into a free fold, which encloses the pallial chamber and covers over the gills.

"The internal shell is developed in a sac formed by an involution of the ectoderm of the mantle. The epipodia unite behind, and give rise to the funnel, while the antero-lateral portions of the foot grow over the mouth, and thus gradually force the latter to take up a position in the centre of the neural face, instead of in front of it. The yolk sack gradually diminishes, and the contained blastomeres are finally taken into the interior of the visceral sac, into which the alimentary canal is gradually drawn." —HUXLEY, "Anatomy of Invertebrated Animals."

Such is the language of a master equally of the art of condensation of language and of anatomy, and who has enriched malacological anatomy impartially with that of other branches of natural science by his researches.

At a later period of development, respiratory movements are performed by the alternate dilatation and contraction of the mantle, and the position of the ink-bag is revealed by its color through the transparent flesh. The shell of the young Sepia, observes Kölliker, by the time it is prepared to leave the nidimental capsule has already formed, but except the nucleus, which is calcified, its fine layers are horny and transparent. The fins are proportionally broader than those of the mature animal.

The development of Nautilus, equally with its nidus is unknown.

Geological Distribution and Development.

In all fossiliferous strata the cephalopods hold a high position by reason of their large development in species and individuals. Those species possessing siphunculated shells of solid texture have been preserved in immense numbers, whilst the more fragile shells, such as Argonauta, do not ascend beyond the pliocene; whether the naked cephalopoda or those provided with a horny pen are of ancient origin we have no means of determining.*

The approximate development of the genera in time may be thus shown:

NUMBER OF GENERA.	PALÆOZOIC.					SECONDARY.					TERTIARY.			
	I. Cambrian.	II. Silurian.	III. Devonian.	IV. Carboniferous.	V. Permian.	I. Triassic.	II. L. Jurassic.	III. U. Jurassic.	IV. L. Cretaceous.	V. U. Cretaceous.	I. Eocene.	II. Miocene.	III. Pliocene.	Recent.
Of Mollusks. . .	49	53	77	79	66	81	107	108	123	148	172	178	192	400
Of Cephalopods.	12	13	14	11	6	9	12	13	20	16	4	3	1	21

The appearance and range of the families of cephalopods in time may be similarly represented:

FAMILIES.	PALÆOZOIC.					SECONDARY.					TERTIARY.			RECENT.
	I.	II.	III.	IV.	V.	I.	II.	III.	IV.	V.	I.	II.	III	
ORTHOCERATIDÆ. .	*	*	*	*	*	*								
NAUTILIDÆ. . . .		*	*	*	*	*	*	*	*	*	*	*	*	*
AMMONITIDÆ. . .			*	*	*	*	*	*	*	*				
BELEMNITIDÆ. . .							*	*	*	*				
TEUTHIDÆ-SEPIADÆ.							*	*	*	*	*	*	*	*
ARGONAUTIDÆ. . .													*	*

* Dillwyn has observed that the shells of carnivorous gasteropods were almost or entirely wanting in the palæozoic and secondary strata; but they were replaced, in the economy of nature, by the almost extinct order of tetrabranchiate cephalopods—of which over two thousand species have been described.

Vertical Distribution of the Families Nautilidæ, Ascocératidæ and Goniatidæ.

GENERA.	Palæozoic Fauna. Silurian. I.	II.	III.	Devonian.	Carboniferous.	Permian.	Mesozoic. Triassic.	Liassic. Jurassic.	Cretaceous	Tertiary.	Quarternary.	Actual.
NAUTILIDÆ.												
Trochoceras, Barr, Hall.		1	61	2								
Nautilus, L.		12	10	8	84	5	47	47	63	15		3
S.G. *Aturia*, Bronn. .										4		
Gyroceras, Konk. . .			16	17	6							
S.G. *Discoceras*, Barr. .		3										
Cyrtoceras, Goldf. . .		90	299	59	26	1						
S.G. *Piloceras*, Salt. .		6										
Orthoceras, Breyn. . .		260	626	131	112	3	14					
S.G. *Endoceras*, Hall. .		46										
S.G. *Gonioceras*, Hall. .		2										
S.G. *Huronia*, Stok. .			8									
Tretoceras, Salt. . .		2	1									
Adelphoceras, Barr. .			2									
Hercoceras, Barr. . .			2									
Lituites, Breyn. . . .		22	1									
S.G. *Ophidioceras*, Barr.		2	6									
Phragmoceras, Brod. .		2	49									
Gomphoceras, Sowb. .		5	87	14	4 ?							
Nothoceras, Barr. . .			1									
Conoceras, Barr. . . } Bathmoceras, Barr. . }		4										
Mesoceras, Barr. . . .			1									
ASCOCERATIDÆ.												
Ascoceras, Barr. . . } Aphragmites, Barr. . }		4	12									
Glossoceras, Barr. . .			3									
GONIATIDÆ.												
Bactrites, Sandb. . .		2		11			2					
Goniatites, De Haan, .			17	180	123							
S.G. *Clymenia Münst.* .				37								
Total (in all, 2487 sp.) .	—	463	1201	459	355	9	63	47	63	19	—	3

Mr. Alpheus Hyatt has remarked that the young of all the coiled cephalopods start with a straight or bent cone, and begin their coil abruptly, always leaving an opening in the umbilicus through the centre of the first whorl. The development of the Nautiloids, in time, is also marked by a gradual involution from the perfectly straight Orthoceras to the *Nautilus Pompilius*, where the expansion of the last whorl conceals the umbilicus. The progress of the Ammonoids, on the other hand, is marked by the gradual uncoiling of the shell, ending with the straight Baculites of the cretaceous; this feature is, therefore, of great importance in a natural classification of these groups.*

Mr. Hyatt has also carefully studied the embryology of the shell of the fossil cephalopoda; and in a richly illustrated memoir, published by the Museum of Comparative Zoology, at Cambridge, Mass., he attempts to prove the development theory by the results of these studies.

M. Joachim Barrande, however, who is the most distinguished of living authorities upon the fossil cephalopods, differs in toto from Mr. Hyatt's decisions. He has published (in 1877) "Etudes Générales," in which he devotes over two hundred octavo pages to a careful review of the entire subject, and reaches the following conclusions:

I. *Generic Types.*

1. Absence of cephalopods in the primordial silurian fauna of all the countries where it has been ascertained to exist; that is to say in about 25 natural basins, largely spread over the two continents. This absence is in harmony with that of the acephala and the rarity of gasteropoda and heteropoda in the same fauna. It is inexplicable by the theories of evolution.

2. Sudden appearance of 12 types of cephalopods in the first aspect of the second Silurian fauna.

   This sudden appearance is as inexplicable as their total absence in the primordial fauna. This number, 12, constitutes nearly half of the 26 types admitted in his studies, among the 3 families: Nautilidæ, Ascocératidæ and Goniatidæ.

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* *Proc. Bost. Soc. N. H.*, xii, 216, 1868.

3. The 12 primitive types show, in their earliest species, the contrast and plentitude of their characters.

   This plentitude and this contrast are above all remarkable in two straight types: Orthoceras and Bathmoceras. One sees also in some species the maximum of size known, as in *Naut. ferox* Bill. of Canada. The plentitude of typical characters and the size not surpassed by later appearing species, are in disaccordance with the slow and successive progress attributed to evolution.

4. The 12 primitive types are very unequally distributed in the palæozoic countries. This distribution indicates no centre of diffusion, no point of departure for evolution.

5. Among the 12 primitive types, are found those the most contrasted in form and structure. Ex.:

   Orthoceras, with straight shell.
   Cyrtoceras, with curved shell.
   Nautilus, completely spiral in the same plane.
   Trochoceras, doubly spiral.
   Bathmoceras, shell straight, but characterized by an obsolete siphon.

   In order to derive from a common ancestor types so much differentiated, one must have an indefinite number of generations and of transition-forms, of which there remain no trace whatever.

6. The 14 types posterior to the 12 primitive types, also appeared as suddenly, without being announced by any transition-form, as for example: Ascoceras and Goniatites. One can apply to them also the preceding observation.

7. The vertical position of the 26 types in respect to their first appearance, offers a combination the most opposed to evolution, for instead of showing a successive progress in the number of first appearances, it presents a rapid diminution thereof. In fact:

   16 of these 26 first appearances (comprising the 12 primitive types) are found within the limits of the 2d fauna.
   8 in the limits of the 3d fauna.
   1 towards the end of the Devonian fauna.
   1 during the Eocene period.

8. This diminution of the apparitions of generic types is in disaccordance with the increase of the number of species during the Silurian period.

In effect, if the new types were formed by the divergence of the species, as supposed by the development theory, the increase of the number of specific forms must entail an increase of the number of generic types. In any case it could not cause a diminution of them.

Then, each of the principal facts that we have given on the subject of generic types, constitutes a grave discordance between the theories of evolution and the reality.

II. *Specific Forms.*

1. We have never acquired the certainty and we have never been induced to suppose that any species among the cephalopods of Bohemia was derived by filiation and transformation from another anterior species. The filiation and transformation are then, in our point of view simply theoretic fictions.

2. No species, to our knowledge, has been transformed to a new generic type, neither by successive slow variations nor by sudden changes.

On the contrary we have ascertained at various times that all the species and all the groups of congeneric forms, which have varied sensibly from their generic type in certain particulars and which appeared to tend towards a new type, appeared and disappeared suddenly, without leaving any posterity preserving the traces of the same character.

3. Our second phase of Fauna No. 3 possesses alone 777 species of cephalopods, that is to say about 31 per cent. of all the species of this order known in the Silurian. Our basin, very remarkable for its small size furnishes about 45 per cent. of these.

These accumulations of cephalopods in surfaces so restricted are in contradiction with the theories of natural selection and of the struggle for existence.

III. *Elements of the Shell.*

The particular study of each of the elements of the shell of the cephalopods. of which we have presented a resumé, shows that none of them have followed a gradual variation in any one direction. On the contrary, we have observed the stability of these elements, notwithstanding their specific and temporary variations. These facts are manifested above all in the genera of which the duration has been the longest, as Orthoceras and Nautilus.

IV. *Stability of the Genera.*

1. Orthoceras takes the second rank, by its longevity, among the generic types, but the first by its richness in species, since it furnished alone about half those of the Palæozoic cephalpods. It traverses every age, commencing with the origin of the second fauna, to the extinction of the Triassic fauna. Its species, very diverse in every horizon, preserve nevertheless their typical features very plainly, in about 1146 forms enumerated in our studies.

   Among the proofs of the stability of the elements of the shell in this genus, we have observed a very remarkable and probably unique fact in palæontology. It is that on Plate 1, of Dr. V. Mojsisovics' "Das Gebirge um Hallstatt," is shown seven species of Triassic Orthoceras, which could be intercalated among the plates representing the Silurian species of our fauna No. 3, without any man of science supposing that he saw the last remains of that type. In fact, they are hardly distinct from the species which characterized the epoch of the most luxuriant vitality of the genus.

2. Nautilus has enjoyed the privilege of an incomparable duration, from the first appearance of cephalopods, at the origin of the second Silurian fauna to the present time. The succession of its species has traversed every geological age, and if it had been subjected to the supposed influences of evolution, it would show us a series of transformations or of progressions which, accumulating, would far remove the present from the primitive forms. We do not see why these extreme forms arising during the existence of Nautilus should not contrast

among themselves like those of the *Amphioxus* and of *Homo sapiens*, between which imaginary evolution has worked, according to theory, in nearly the same period of time.

But the material facts discovered by palæontology and accessible to everyone, dispel all illusion. In effect, the Nautilides, notwithstanding the great number of their specific forms, which must exceed 300, depart so little from their initial type, throughout the geological ages, that the merest novice would not hesitate in any case to recognize their generic nature. The variations or differences among the species, oscillate without any tendency to continue in a single direction so as to found a new type. In the actual fauna, Nautilus does not show, between its forms and the primitive forms, any greater differences than those which all naturalists agree in considering as purely specific. Even the Triassic Nautilides show less affinity to existing species than do the primitive forms. The theoretical evolution of the cephalopods, like that of the Trilobites, appears to us to be imaginary, without any foundation in fact.*

Dr. Paul Fischer, in a notice of Barrande's work, whilst acknowledging the strength of the facts and observations brought forward by that distinguished palæontologist against the development theory, does not consider them conclusive: "The type Goniatites, says M. Fischer, has always been considered by evolutionists as a natural transition between the Nautilus with its very simple partitions and the foliaceous sutures of the Ammonite; an opinion which is strengthened by the appearance of Goniatites chronologically intermediate between the other two. In order to show the extreme difference which exists between the Nautilus and the Goniatites, M. Barrande has studied the characters of the initial shell in these two genera—a study which has acquired great importance since the publication of Mr. Alpheus Hyatt's "Fossil Cephalopoda."

Mr. Hyatt has shown that the initial chamber of *Nautilus Pompilius* shows an elongated nearly linear cicatrice, enclosed by an elliptical surface slightly depressed. He supposes that the ovisack was attached to the elliptic surface, and that the

* "Céphalopodes, Etudes Générales," 224–230, 1877.

cicatrice is the vestige of an opening which placed this ovisack in communication with the initial air-chamber of the shell; but he has never seen this supposed ovisack, which is hypothetical. For him, the Nautilus is a cephalopod which has lost its ovisack.

In Ammonites and Goniatites the initial disposition is entirely different. The ovisack is plainly visible, globular or ellipsoidal, more dilated than the part contiguous to the chambered spire. No appearance of a cicatrice. It suffices, consequently, to examine the first chamber of a cephalopod to class it among the Nautilides or the Ammonides and Goniatides.

M. Barrande has shown that the initial appearance of the shell of Nautilus is exhibited without any change through all the geological periods to the present time. The fissure is supposed by M. Barrande to have placed the mollusk contained in the initial chamber in communication with a transitory organ, either a vitelline vesicle (which, to M. Fischer, appears inadmissible) or to a natatory bladder, etc.

From the first appearance to the final extinction of the Goniatidæ and Ammonitidæ, they always show a typical ovisack; it is therefore impossible to derive them from the Nautilidæ, as supposed by the developmentalists. This difference has induced M. Munier-Chalmas (*Comptes Rendus*, Dec. 29th, 1873) to separate the two former from the tetrabranchiate or tentaculiferous cephalopoda (Nautilidæ), and to unite them with the dibranchiate or acetabuliferous group (Spirulidæ and Belemnitidæ), which are provided with an ovisack.

It still remains to ascertain whether the presence or absence of the ovisack has the systematic importance attributed to it; what is its nature and what is the purpose of the cicatrice. The word ovisack may be badly chosen because it supposes the existence of calcareous envelopes to the eggs.

One might discuss and wonder a long time on this subject until a direct observation on the embryogeny of Nautilus shall give us the true solution. It is thus that the question of the parasitism of the Poulpe of the Argonaut was agitated with ardor until the day that Duvernoy showed the embryo of Argonaut to be provided with a shell in the egg.

M. Fischer concludes. "Is the doctrine of evolution overthrown by the facts M. Barrande has produced? I do not think it. He has proved that there existed among the ancient cephalopods two great types. which have continued separate during the entire period of their existence; but the evolution of each of these types remains extremely probable, and conforms to observations made upon them. In such matters one cannot, in effect, ask more than a probability." *

Geographical Distribution.

Most of the species of Octopods and the Nautilus are littoral in habit, and have thence been conjectured to enjoy but a limited distribution; and which is held to justify the multiplication of species. This reasoning is, however, fallacious, as it is well known that many littoral mollusks, not nearly so well provided with means of swimming, have become world-wide in distribution. I shall show hereafter, not only that particular species of Octopus are known to inhabit the shores of distant countries, but that a large proportion of these species which have been distinguished by slight and mutable characters, and by their geographical distribution, will probably need to be united when sufficiently studied. This probable extensive distribution of living littoral species corresponds with observations made upon fossil species of Ammonites, Nautilus and other chambered genera, which are proved to have been littoral in habit by their occurrence only in deposits representing ancient sea-shores. Not to multiply examples amongst these fossils, it may be mentioned that *Nautilus simplex* occurs in Europe, East Indies and Texas; that *Ammonites Rotomagensis* is found in Europe, East Indies, N. and S. Africa and S. America; and that *Baculites anceps* had even a greater distribution. Nevertheless, temperature has been observed to have some effect upon the distribution of the living octopoda of Europe, similar but distinguishable forms or species inhabiting its northern seas, from those of the Mediterranean. As in Molluscan life generally, the development of specific forms has been greatest in tropical waters.

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* *Jour. de Zool.*, iv, 419, 1877.

It is altogether probable that pelagic cephalopods, highly organized, with powerful locomotive apparatus, and frequently attaining great size and strength, may enjoy a distribution fully equal to that of the littoral species: such is known to be the case in some species which, normally circumboreal in distribution, are found nevertheless extending into temperate latitudes in both oceans.

Habits of the Cephalopoda.

I. Observations on certain points in the natural history of the Cephalopods. By Dr. Paul Fischer.

It is difficult to study the cephalopods in the living state. Most of them, accustomed to move freely in space, will not accustom themselves to the straightened limits of the aquarium; besides the discharge of ink, made upon the slightest disturbance, discolors and obscures the water for entire hours. Except some good figures of Poulpes, there are no really good representations of these animals, because they have always been made from dead specimens.

The observations recorded were made in August, 1866, at the aquarium of Arcachon, Gironde, France. Besides the usual glass cases, there are here vast basins with earth bottoms, and of moderate depth, which receive the results of the fishery on the shore itself. Without this commodious arrangement, it would be impossible to preserve living, the very delicate animals.

Sepia officinalis.—The fishermen gather the young individuals, called *Casserons*, for food. When caught for the aquarium, they are at first placed in the great basins; they show themselves very timid, discharge inky clouds, and hide under floating objects; always shaded, they remain immobile in the horizontal position, nearly touching the earth by their ventral surface. After some days of repose, they are transferred to a glass aquarium.

The normal position of the Sepia is horizontal, the fins undulating gently, the sessile arms joined at their extremities, forming a sort of pyramid or tetrahedon. In this position the appearance of the head and arms is very like that of an elephant's head with the trunk. The tentacular arms remain contracted within the others when in repose; a position difficult to understand, as after death they are found to be more than double the length of the sessile arms. Sometimes the first pair of arms are raised into a vertical position, like antennæ, the others preserving their normal attitude; sometimes, also, the fourth pair of arms drop towards the earth for a few moments, and much elongate themselves.

The coloring of the Sepia is eminently variable; but if the day is clear, the dorsal surface and arms are magnificently striped; the edges of the fins are black, and their superior face is ornamented with spots of the same color. On the back of large individuals is seen two large obscure spots, which vary in intensity and sometimes entirely disappear. The eye is fatigued in following the incessant variation of coloring caused by the constant movement of the pigment cells, and the metallic reflections of the head and arms are glorious beyond human skill to reproduce. The skin is usually smooth; but when the animal becomes irritated, it shows granulations, principally on the head and back. This is accompanied by a retraction of the arms, which appear both shorter and narrower; the extremities no longer touch, but curve slightly. At the same time the colors change, a uniform gray tint takes the place of the striped bands. The approach of death is equally announced by a change of colors, which grow dull.

The swimming of the Sepia is differently effected, according to the speed required. A moderate progression is equally easy forwards or backwards. When the animal moves forward, the body remains horizontal; the tentacles, united and extended in front, rest on the fourth pair of arms. The Sepia follows in this manner the course of the water, the resistance of which bends the extremities of the united arms. A moderate backward movement is effected in the same manner; but the tentacles are more elongated and their extremities are somewhat parted; the arms are raised to the line of the body. The undulations of the fins commence at the front or rear, according to the direction which the animal takes. This method of swimming, due entirely to the fins, is not slow, for the normal movement of the Sepia is easy, elegant and rapid; but an occasion of disquietude, as the sight of an enemy, or a noise, causes a much accelerated, jerky and retrograde movement. To effect this the animal spreads its arms and suddenly reunites them; whilst the fins, reduced to inaction, are folded upon the ventral face of the body, the posterior extremity of one of them covering that of the other.

This accelerated action is then due to the movements of the arms, which cause a series of extremely rapid progressions, in which, perhaps, the funnel assists by its discharges. It is erroneous to regard the funnel, as some have done, as the principal or only swimming organ of the Cephalopods.

Capturing, by the seine, two Sepias of somewhat unequal size, I was surprised to find their arms interlaced and their mandibles apparently in contact. They were separated and placed in a bucket of water, when they immediately resumed their position in contact; and this was again renewed, an hour afterwards, in one of the basins of the aquarium. The larger of the pair threw itself upon the smaller; the first pair of arms were raised, the fourth pair depressed, the others interlaced; and the two animals embraced, mouth to mouth, for about five minutes. During this contact the Sepias maintained themselves in the water with scarcely a movement. Their eyes, usually narrowly contracted, became circular, largely dilated, and kept a fixed stare; with the pupil jet black and brilliant. When the animals are disengaged, they advance slowly; the male is followed by the female, which swims above him: she seemed to be unable to abandon him, and lets fall her fourth pair of arms upon his back. The sexual excitation seemed to endure longer with the female than with the male, for the dilatation of her eyes still continued, whilst his had resumed their usual form.

The distinction of the sexes, ordinarily, appears impossible without dissection: it is only prior to oviposition that the females may be known by the amplitude of the abdomen. The females, when adult, are about a third larger than the only male that I have seen, and I believe that the latter are more rare than the females; a fact observed by Needham in the Calamaries also.

This description corresponds with the observations recorded by the Father of Natural History, Aristotle, and recalls the passage of Oppian, who echoes the belief of his times in the passage: "The Sepias are unhappy in their loves. The fishermen do not bother themselves with spreading their nets for them; they catch a female, when the others immediately fall upon her, grasp and enlace their arms. This effort of their love ceases not till the fishers have raised them into their boat; even then they remain united." A somewhat similar account is found in Vérany's work on the Cephalopods of the Mediterranean, where it is possibly derived from the verses of Oppian.

The deposition of the eggs occurs some days after fecundation. I have been a witness to the deposition of three or four eggs, but I was not able to distinguish the method of the operation. A female laid about one hundred eggs, about fifty in a corner of the aquarium, and fifty on the opposite side. These eggs were enrolled by their peduncles around the long leaves of *Zostera marina.* The larger part of the eggs were laid in the night, for I remarked them in the morning for the first time; they were already black.

When the Sepia is laying, she embraces the leaf of Zostera with her tentacles, and a few instants afterwards the egg is attached. The female removed herself but little from her eggs, but she appeared to me to be sick, exhausted; she died three days after having commenced oviposition, and only a few hours after having attached her last eggs. I do not know whether the death of the animal is attributable to parturition; but on this hypothesis I cannot help thinking of Oppian's recital of the death of the Poulpe: "The fatal marriage of the Poulpe and its cruel death rapidly succeed each other. No sooner does he quit the female, than he falls exhausted on the sands. The female dies also from the pain of the laborious efforts of parturition." Aristotle also says: "The Sepia lays her eggs near the earth, among the algæ. She only lays them at several efforts, as though the operation is painful to her."

I opened the female which died during parturition, and found the ovary filled with a considerable quantity of eggs in all stages of development; the most advanced were already furnished with a white and opaque covering, but none of them were black like those attached to the Zosteras. The black color, then, is acquired at the moment of deposition, and it is probably due to a secretion of the glands which surround the oviduct. The coloration of the eggs has not escaped the observation of

Aristotle, but the explanation which he gives is more than doubtful. The very opaque and very dark skin of the excluded egg, later becomes thinner and nearly translucid. At the last period of development, if the skin is torn away and the vitelline sack detached, one can introduce to the world, as I have often done, the young Sepia. It swims immediately, and changes color with the greatest facility.

The coloration of the Sepias several centimetres in length is more variable than that of the adults. The zebra-like black bands are not seen, but the general tint changes instantly from gray to wine-brown, to violet, to green. The young Sepias sink into the sand, only showing a part of the back and the head; they swim like the adults, but ascend and descend more frequently.

The eye of the Sepia has a very strange appearance; the dark pupil representing exactly a ω. It is furnished with an upper lid, colored by chromatophores, and a narrower, whitish under lid; there is also a very distinct palpebral sinus.

In the Poulpe (Octopus) the pupil is transverse and rounded at its extremities. I have never seen it change its form. As to the Calamaries, I have not been able to study their eye living, on account of the extreme mobility of these animals.

The sea-water destined for respiration enters the cephalic extremity of the branchial sack, and leaves by the siphon. The alternate movements of the openings of the sack and siphon can be readily seen.

The branchial sack in a number of adult Sepias was dilated from seventy to seventy-two times a minute, but in the young, about an inch long, the inspirations reached 140 in a minute. This result surprised me; it confirms, for animals of variable temperature, the law established for those of fixed temperature, that the number of inspirations is in inverse ratio to the age. The Poulpe respires more slowly; I only counted thirty-eight to forty inspirations in a minute in the only individual which I have examined, the size of which was inferior to that of most of the adult Sepias. This difference is due, perhaps, to the much larger size of the branchial sack of the Poulpe, which permits it to introduce at one time a more considerable quantity of water than the Sepia.

Loligo vulgaris.—I have observed several Calamaries of moderate size; these animals are always in motion, which is rapid and jerky. I never found them in repose, for they are essentially pelagic, and only approach the coast to oviposit.

The Calamary completely extends its arms and keeps a position more or less oblique, but approaching horizontal. The arms are united into a single flattened mass, sharp at the summit, by reason of their unequal length; the tentacular arms, with their extremities applied one to the other, form this extreme point.

When the Calamary swims forwards, the animal takes an oblique position, the head directed downward; when it swims backwards, on the contrary, the head is raised and the fins depressed. In forward motion the extremity of the tentacles is bent down; in backward motion it is raised. This ordinary swimming is sensibly more rapid than that of the Sepia, but if the Calamary is disquieted it is off like a flash. Rapid motion is always retrograde; when the fins are folded up and the funnel brought into use. After having seen the rapidity with which the Calamary darts through the water, I can understand how it sometimes shoots out of the water and falls on the deck of vessels.

My Calamaries would not take nourishment; they died at the end of a few days, without having modified until the last moment their habitual activity.

Octopus vulgaris.—The Poulpe is timid and hides itself under rocks. Its arms touch the earth by their cups, and are bent behind; those of the first pair are thus widely separated. The sack is incurved from front to rear, and describes a curve with the concavity inferior. Thus placed the animal examines all that passes around it. If one gives it something to eat, it is seen to elongate slowly the first pair of arms as far as its prey, and to draw it towards its mouth. I have never observed the Sepia eat, and consequently do not know whether it grasps its prey by means of its tentacular arms or by the sessile arms of the first pair.

I will not speak here of the changings of color in the Poulpe; they are more varied and more rapid than those of the *Sepia;* and at the same time the rugosities of the head and sack appear and disappear with great rapidity.

The natation of the Poulpe does not at all resemble that of the other cephalopods. To swim, the Poulpe raises its sack above the arms, fills it with water, and, at the moment that the water leaves the funnel, suddenly closes its arms—which are furnished with a swimming web at their base. The movement of the animal is thus very oblique, and it is also heavy and clumsy, as being unused to that mode of locomotion.*

Sepia officinalis.—The use of the tentacular arms of the Sepias was absolutely unknown to me until I had the satisfaction to see them in motion on a morning of the month of August (1867). A case of the aquarium had contained for nearly a month a Sepia of medium size, which, during that time, had taken no nourishment. I threw to it a rather large-sized fish (*Caranx*), which swam towards the retreat of the Sepia—who had hardly perceived it, when, with prodigious celerity and precision, he unrolled and launched forward his tentacular arms, seized the fish and drew it towards his mouth. The tentacular arms then retracted and disappeared, but the sessile arms wrapped themselves closely around the head and anterior portion of the body of the unfortunate fish—which never made a movement after it was caught. The Sepia swam about easily in all directions for about an hour, eating the while; it then let the remains of the fish drop to the bottom of the aquarium, having opened the skull and devoured the brain as well as a portion of the muscles of the back.

The use of the tentacular arms is then no longer doubtful; they serve for the seizure of food. I have been able to verify this fact a second time in examining the Calamaries—which pursued a troupe of little fishes, capturing them with these members. Moderate forward or backward progression is not due solely to the fins as I have previously stated, but is assisted by the expulsion of water from the funnel; if the animal move forward, the funnel is recurved in front, and forms nearly a right-angle with the body; in retrograde movement the siphon becomes horizontal; it is placed to the right or left when the Sepia would turn, and is strongly recurved from front to back when it would mount to the surface of the water.

* Dr. Paul Fischer, *Ann. des Sc. Nat.*, 5 ser., vi, 308–320, 1866.

The variations of form of the siphon are indisputable, and one cannot doubt their influence upon the direction taken by the animal, but the marginal fins are not less useful; their undulations commencing anteriorly when the animal moves forward, and posteriorly in backward movement; they change suddenly as the direction may be varied. The same facts were remarked with regard to the Calamary.

Octopus vulgaris.—During 1867 I had the opportunity of studying seven individuals, of which three were pretty large. One of these quit his dwelling to explore the hole occupied by another, who irritated, changed color and endeavored to seize the intruder with one of the arms of his second pair. But whether the cups failed to adhere to the body, or whether the Poulpes possessed the means of disembarassing themselves, the combat did not become serious.

The second pair of arms (which are the most elongated) serve principally for attack or defense; those of the first pair are mostly employed in exploration; they glide about among the rocks, and if they come in contact with food, draw it towards the mouth.

The Poulpe moves but little during the day; he executes, sometimes, a very singular manœuvre; his arms make rapid worm-like movements, writhing and twisting together.

The variations of color occur occasionally without apparent cause. I have seen, but only once, a Poulpe present a deep vinous color upon one-half of its head and sack, whilst the other half preserved a pale grayish tint. When the body becomes tuberculated, a sharp tubercle may be seen at the extremity of the sack.

The Poulpes are very voracious. They were given daily a quantity of *Cardium edule*, which they seized and held close to their mouth, concealed under the interbrachial membrane at the base of the arms. After a variable period, but little surpassing an hour in duration, they rejected the valves, opened, and containing only some remains of the mollusk. These valves were perfectly intact; one could not perceive any fracture or trace of teeth; the Poulpes then possess some means of causing their victim to relax its retractor muscles and open its shell—perhaps the victim is asphyxiated. A crab taken from a Poulpe one or

CEPHALOPODA. PLATE 1.

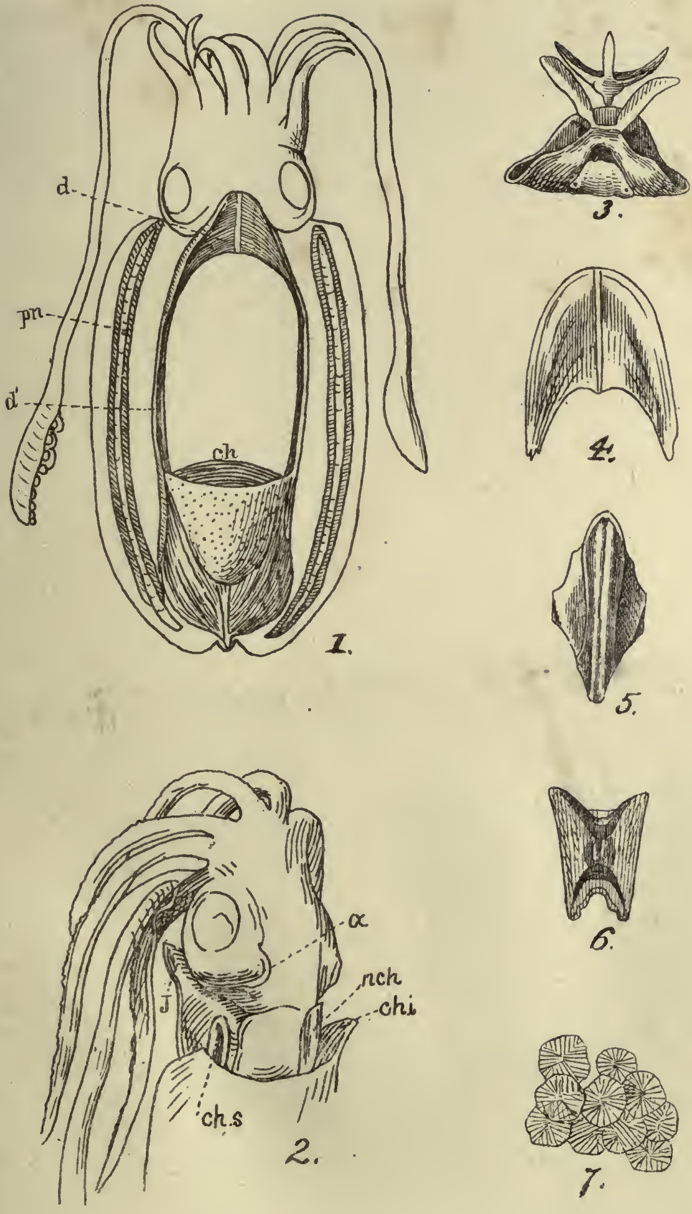

Fig. 2.

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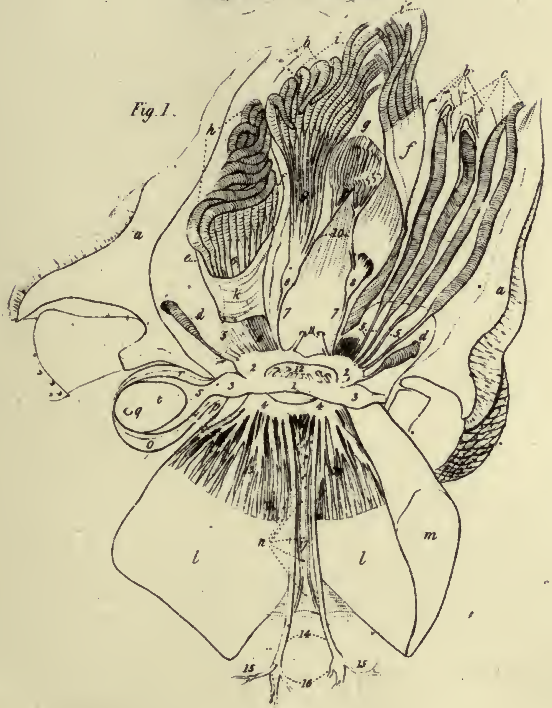

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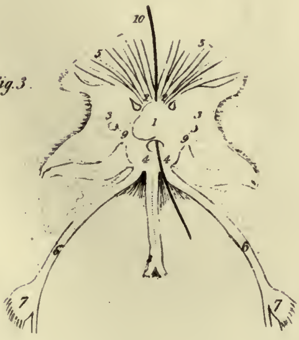

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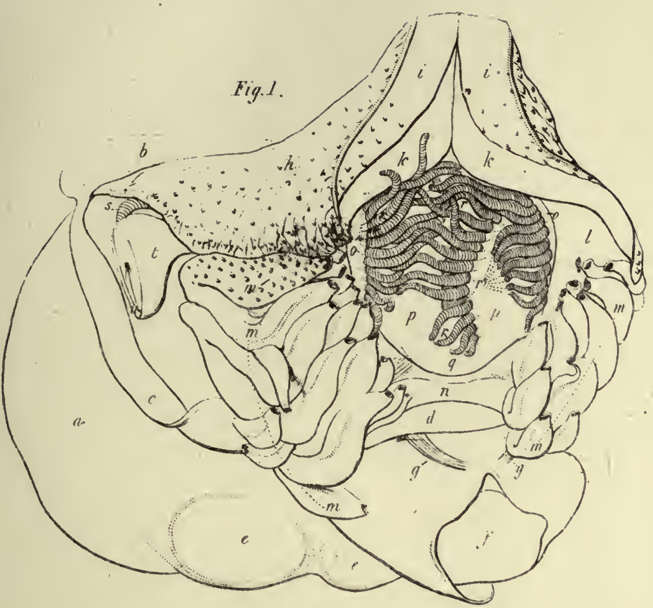

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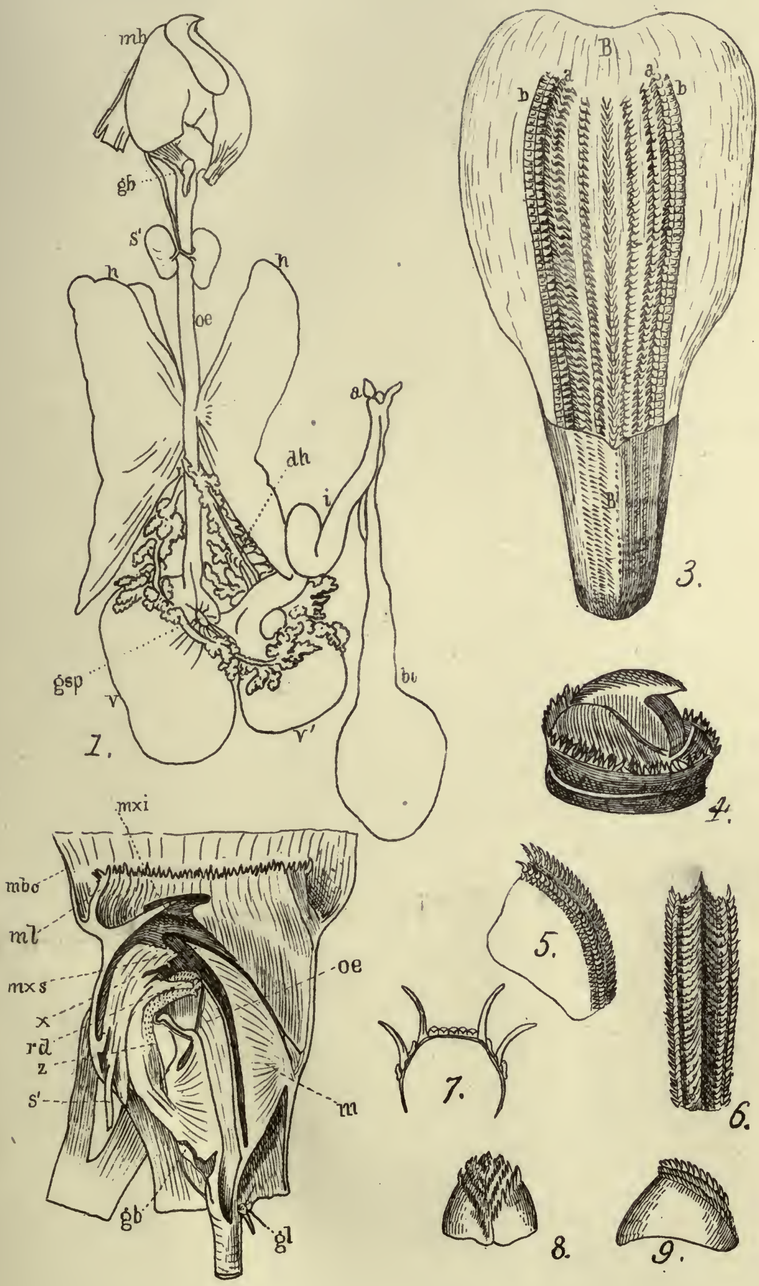
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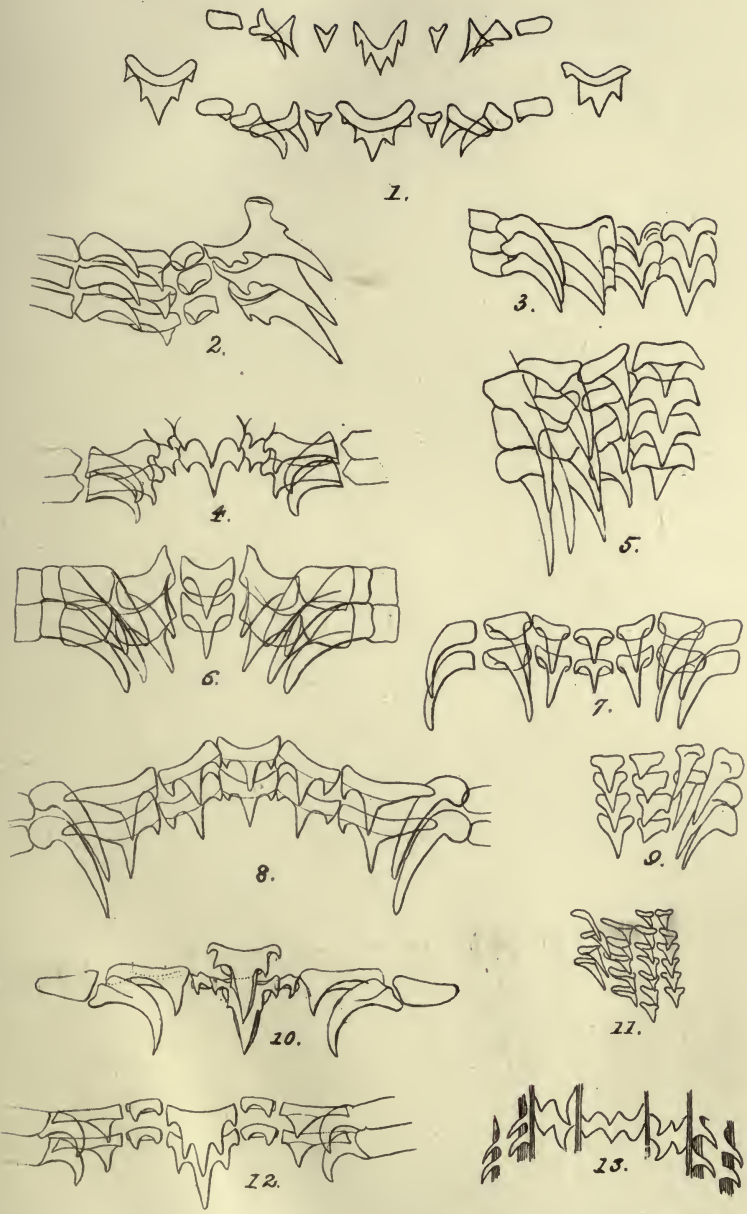
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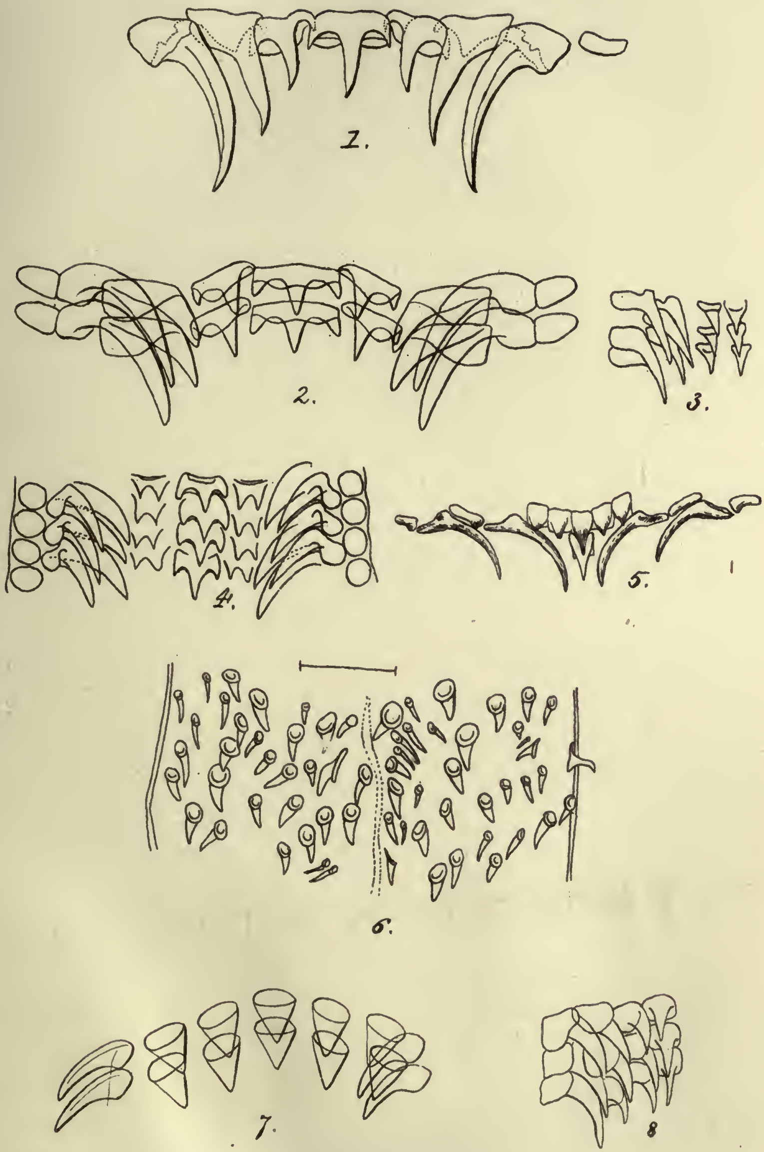
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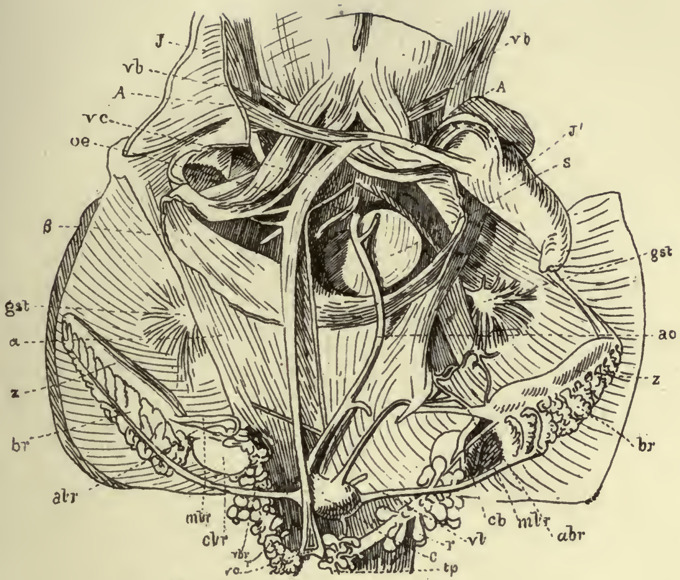
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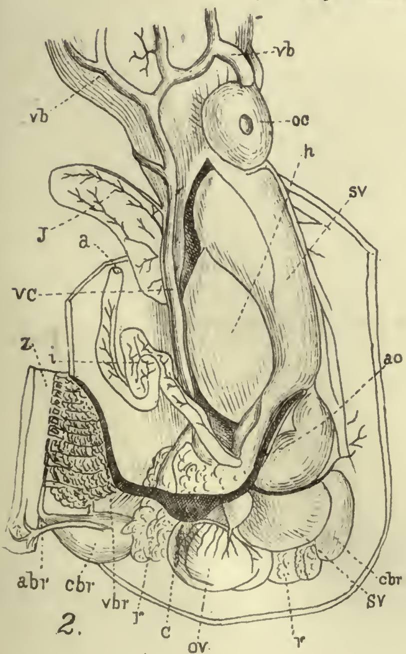
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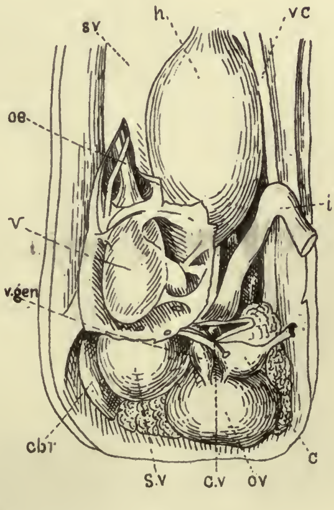
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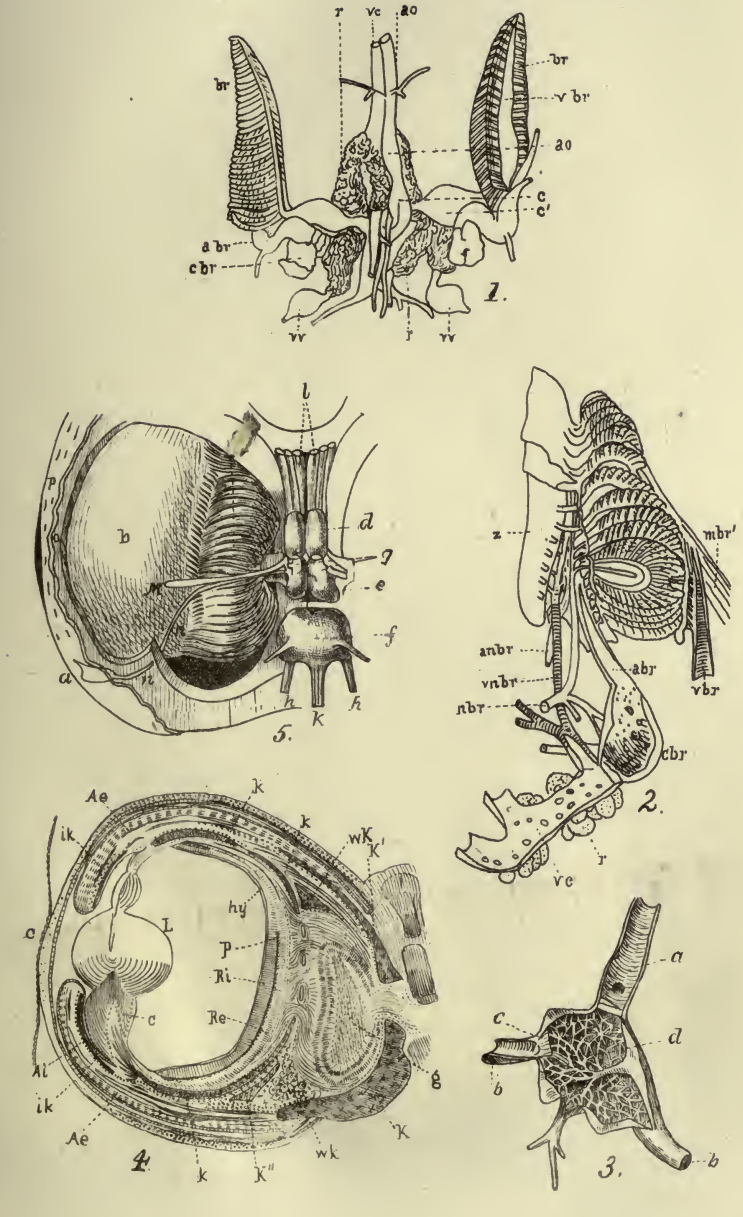
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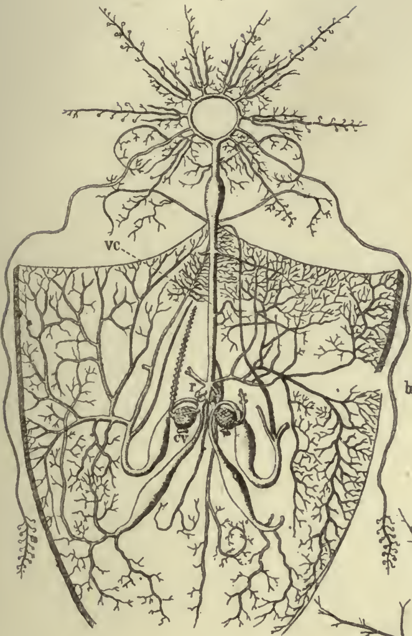

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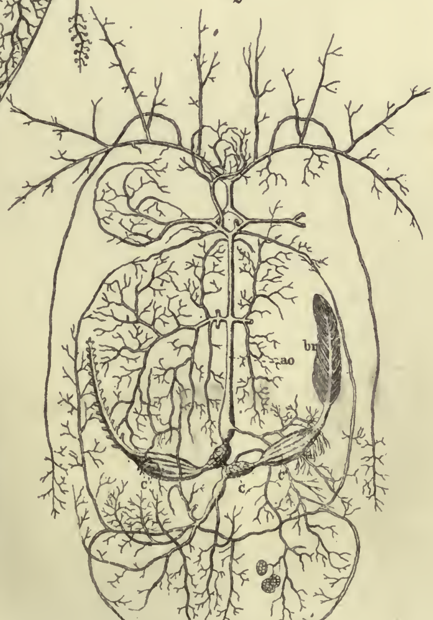

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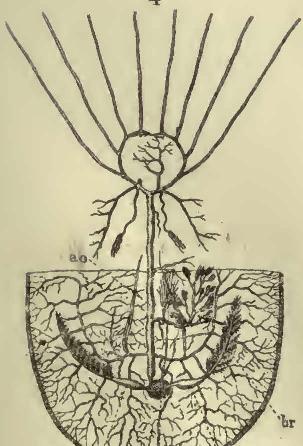

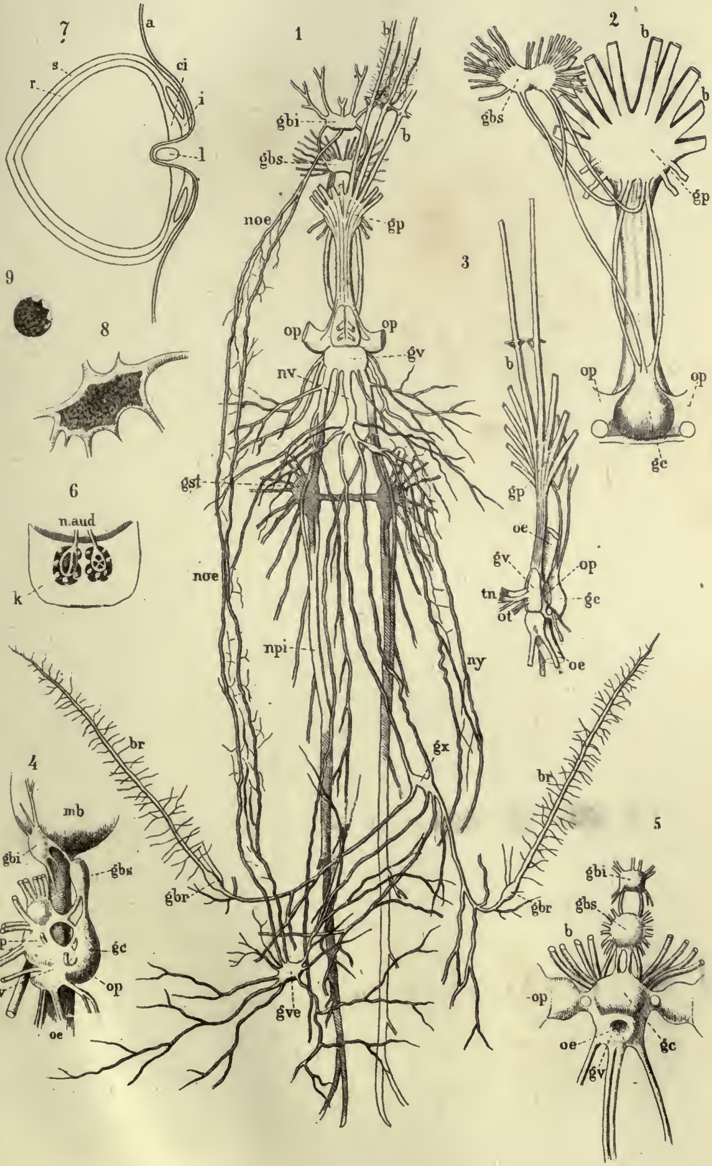
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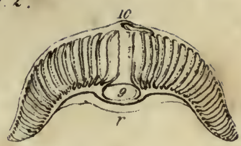
Fig. 2.



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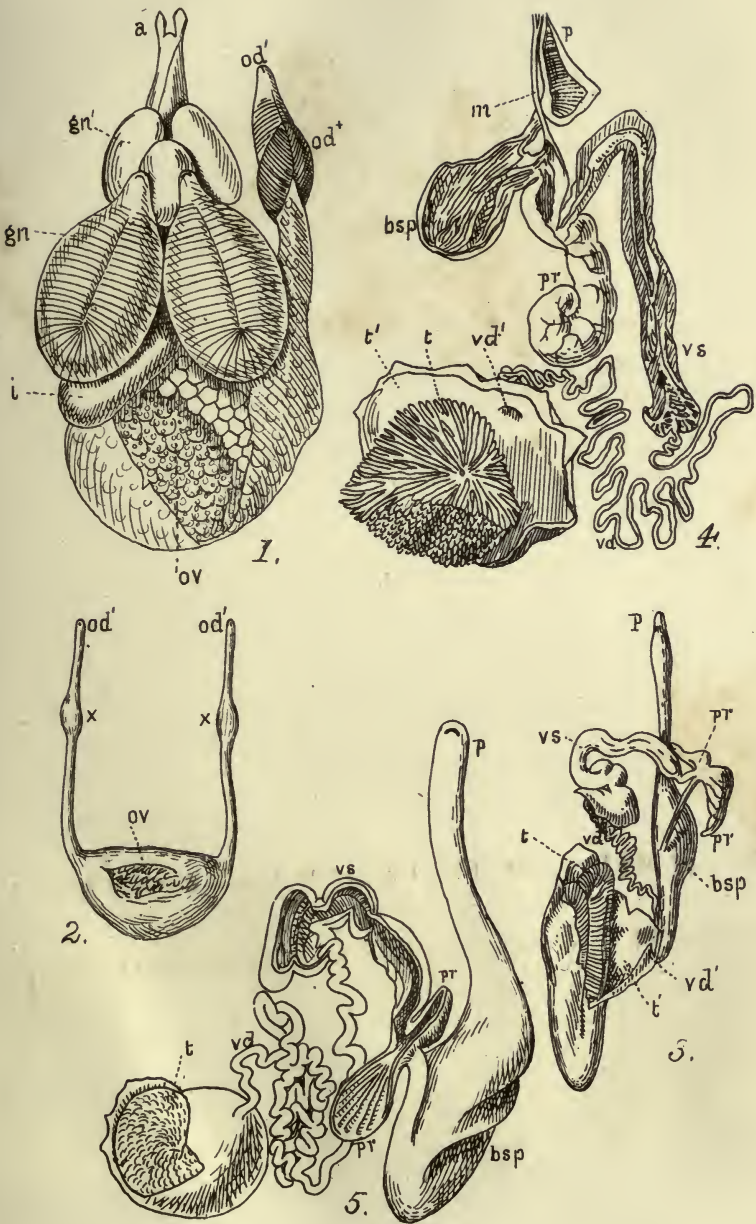
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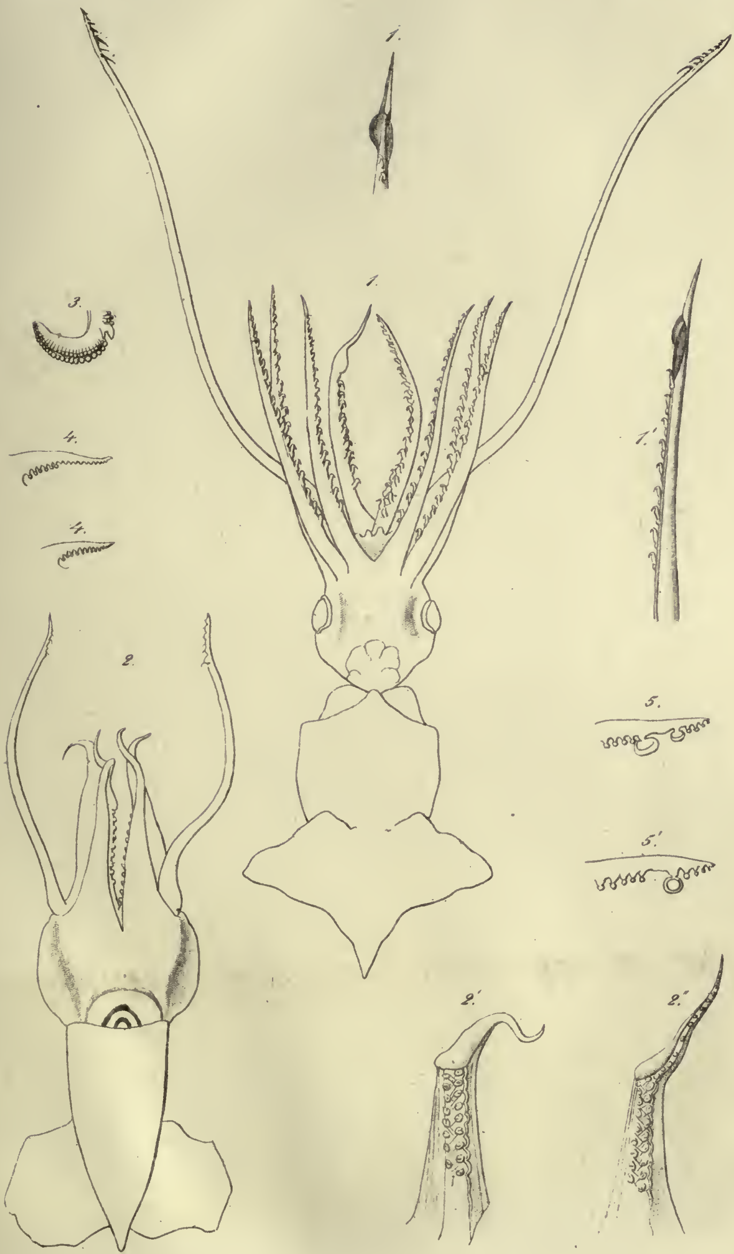
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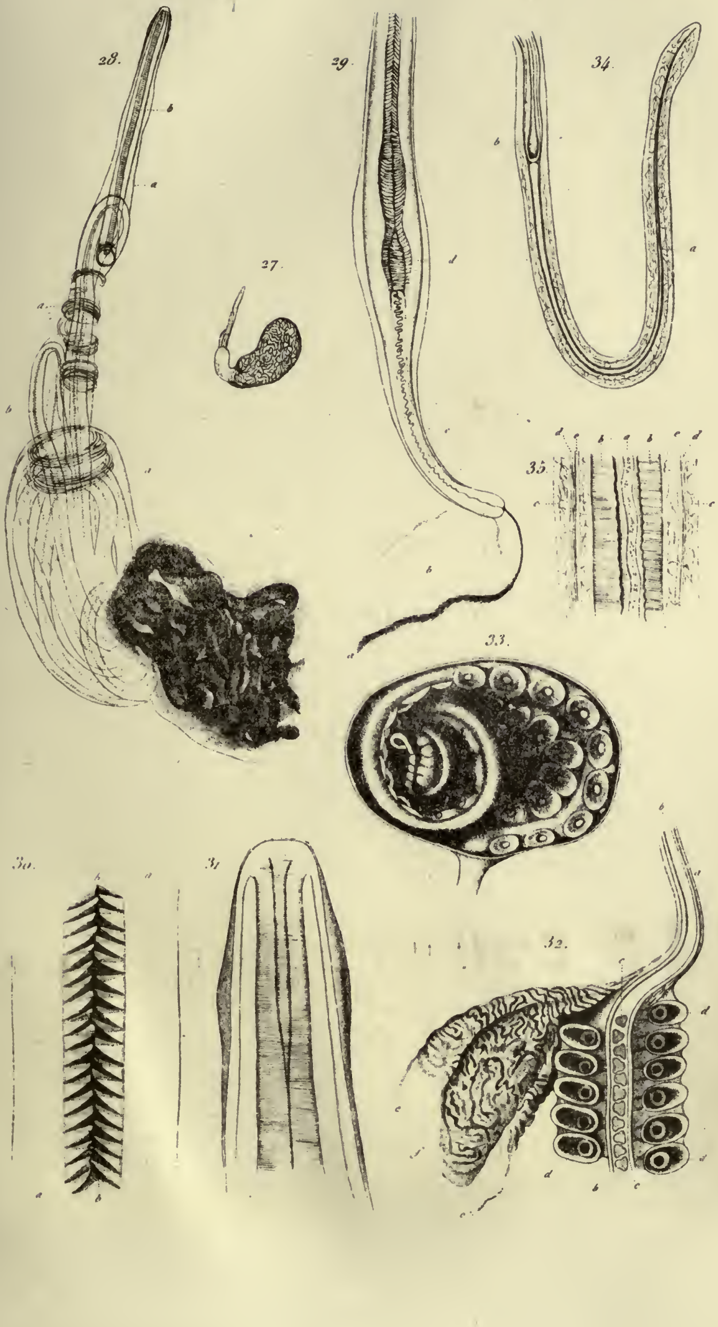
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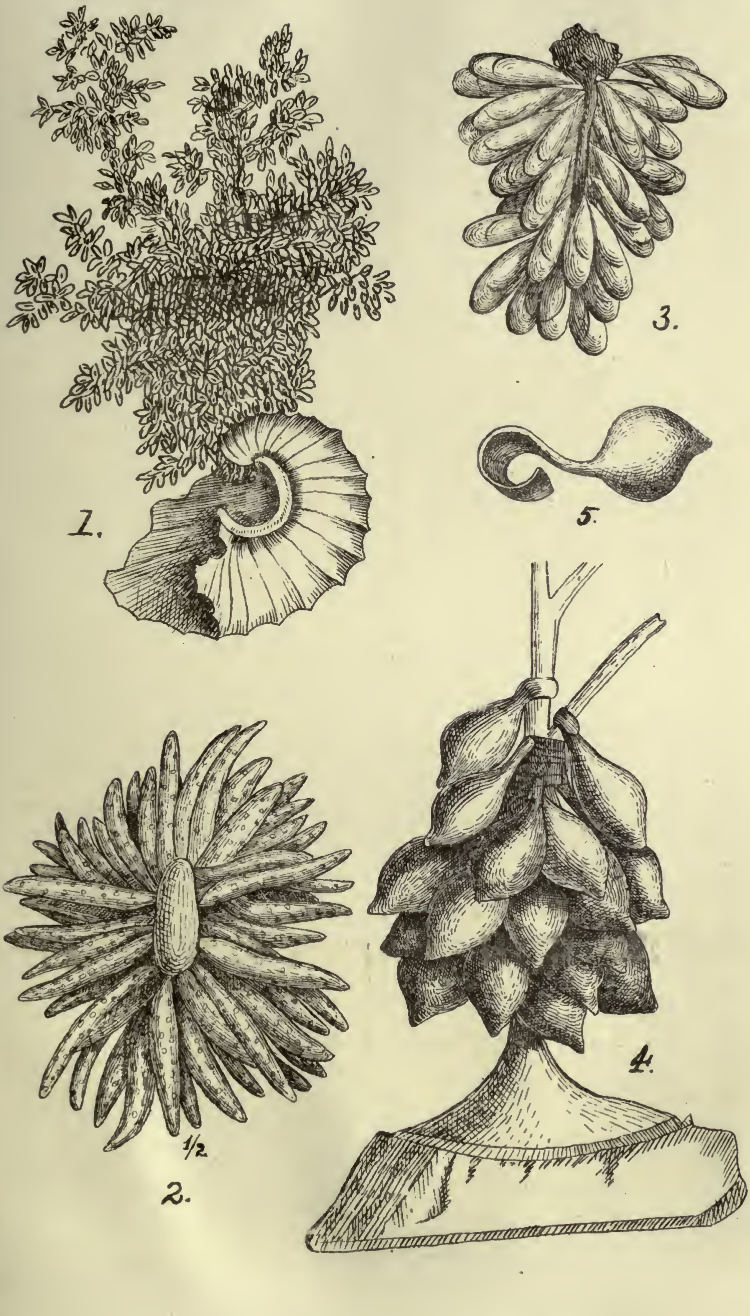
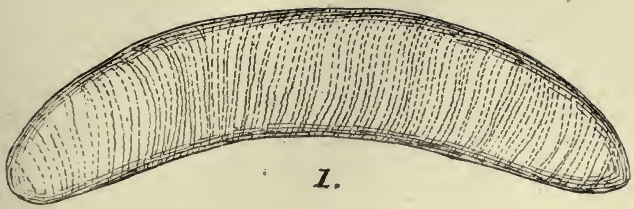
CEPHALOPODA. PLATE 19.





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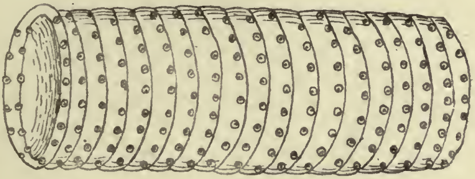

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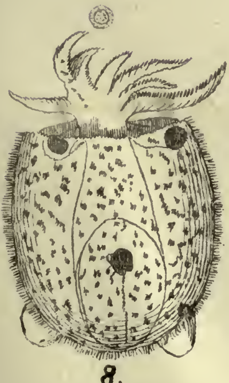

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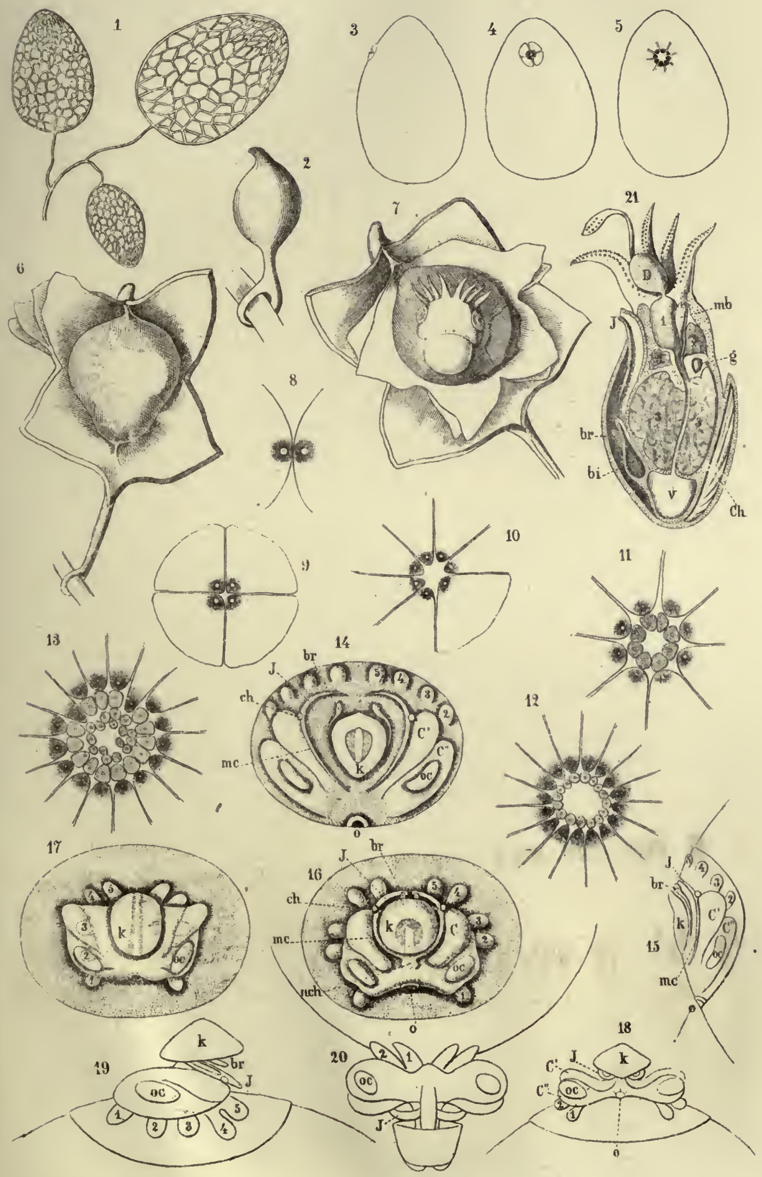
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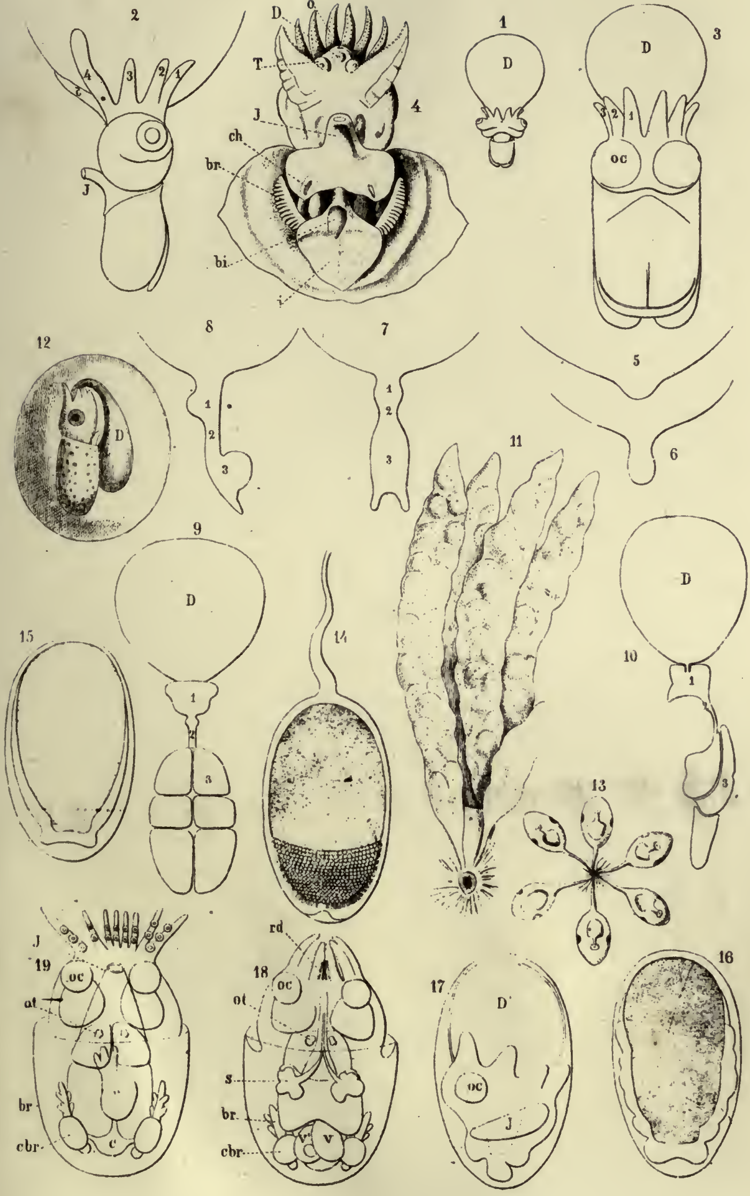
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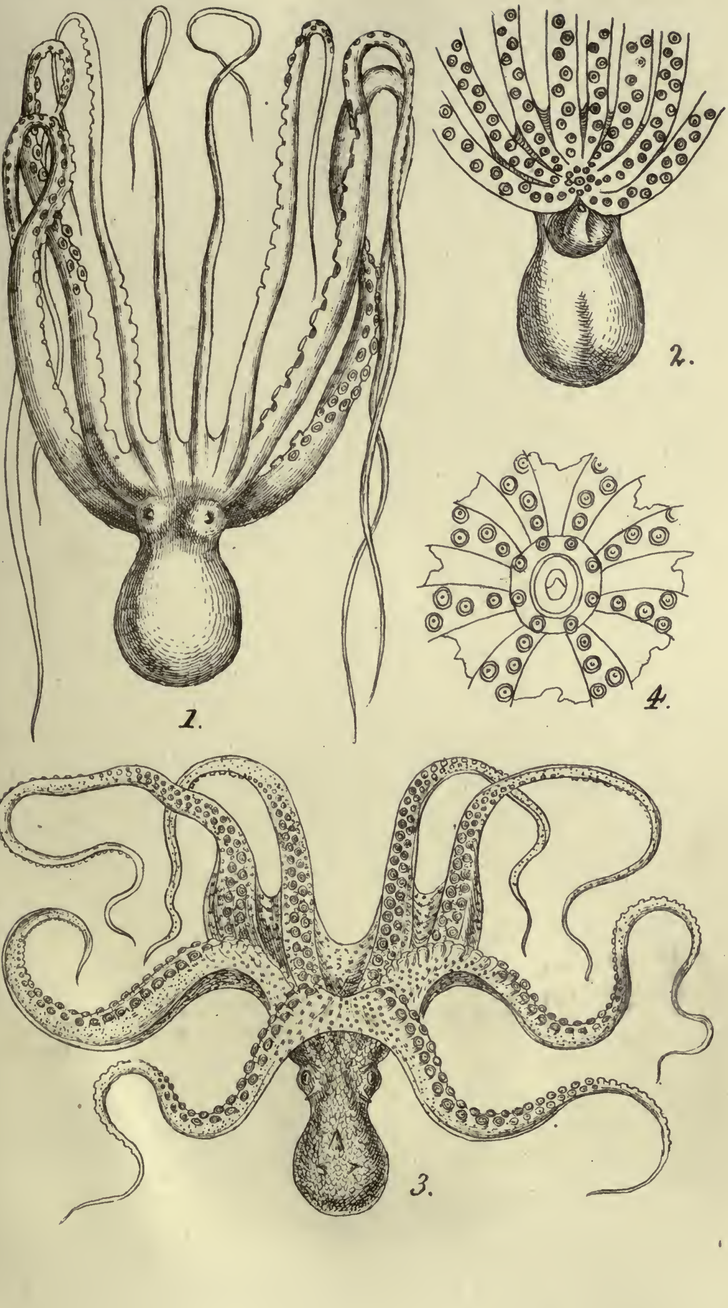
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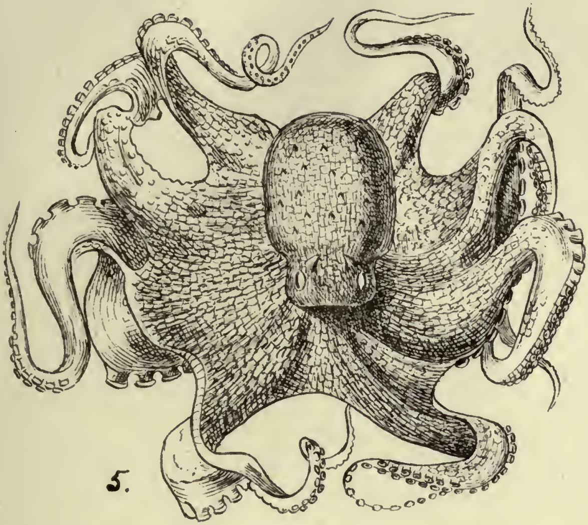

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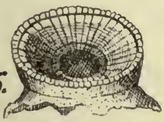

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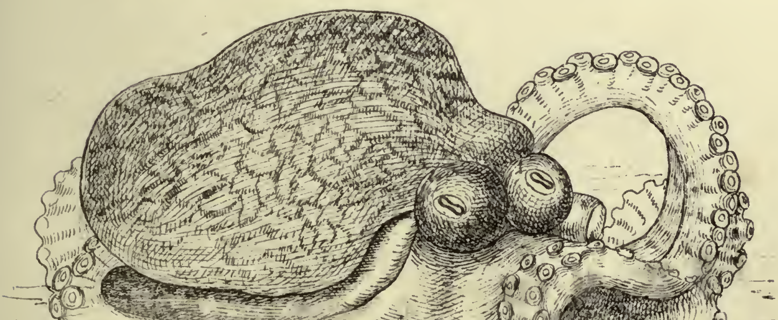

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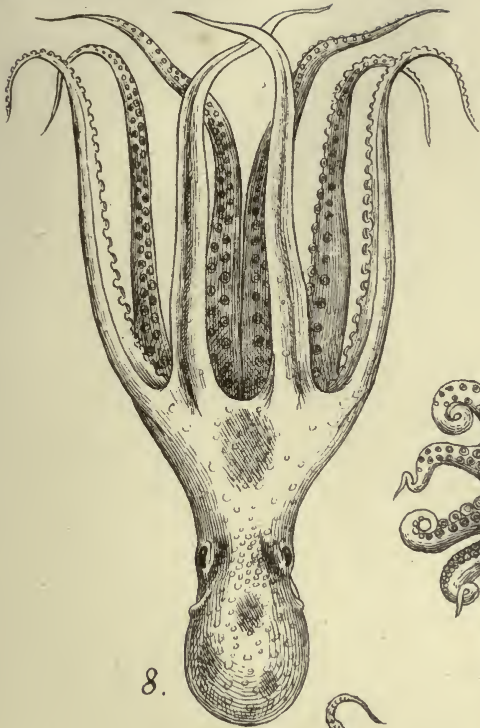

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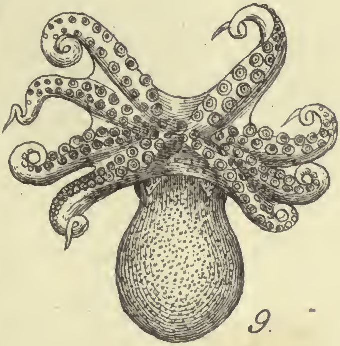

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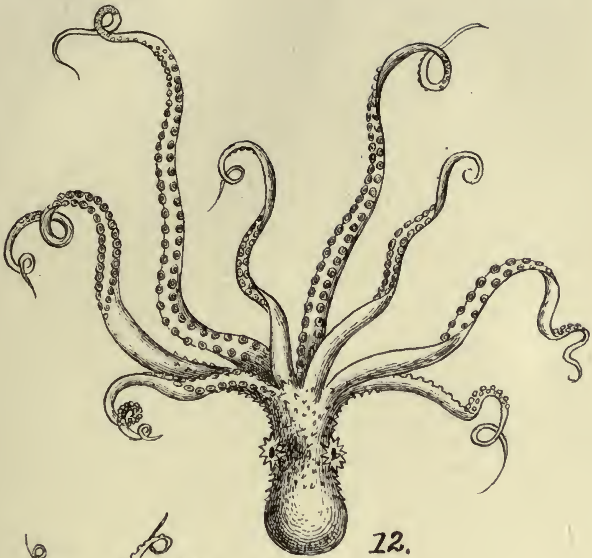
CEPHALOPODA. PLATE 26.



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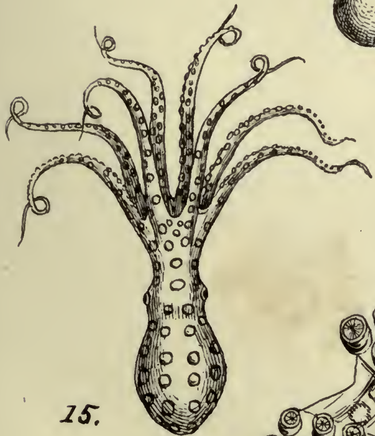

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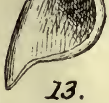

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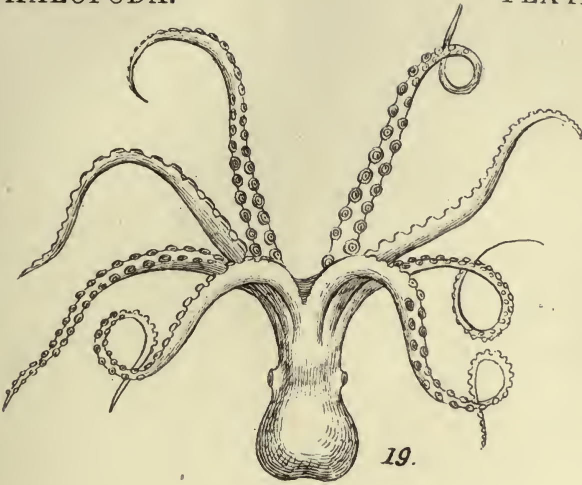

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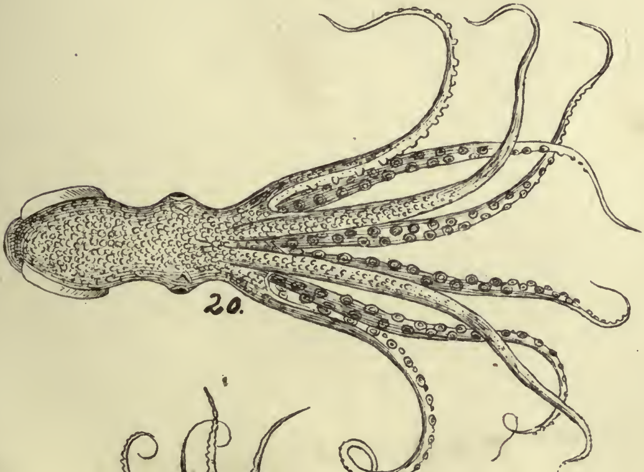

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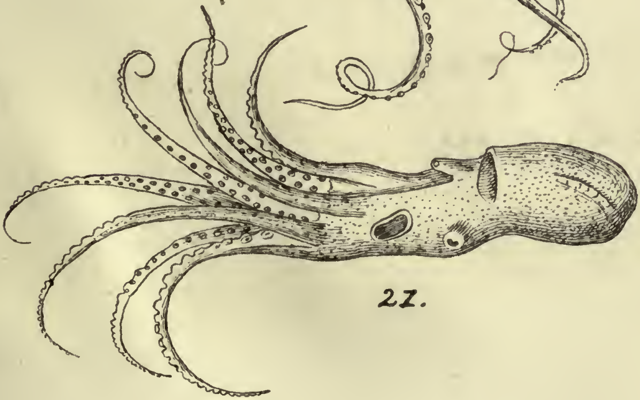

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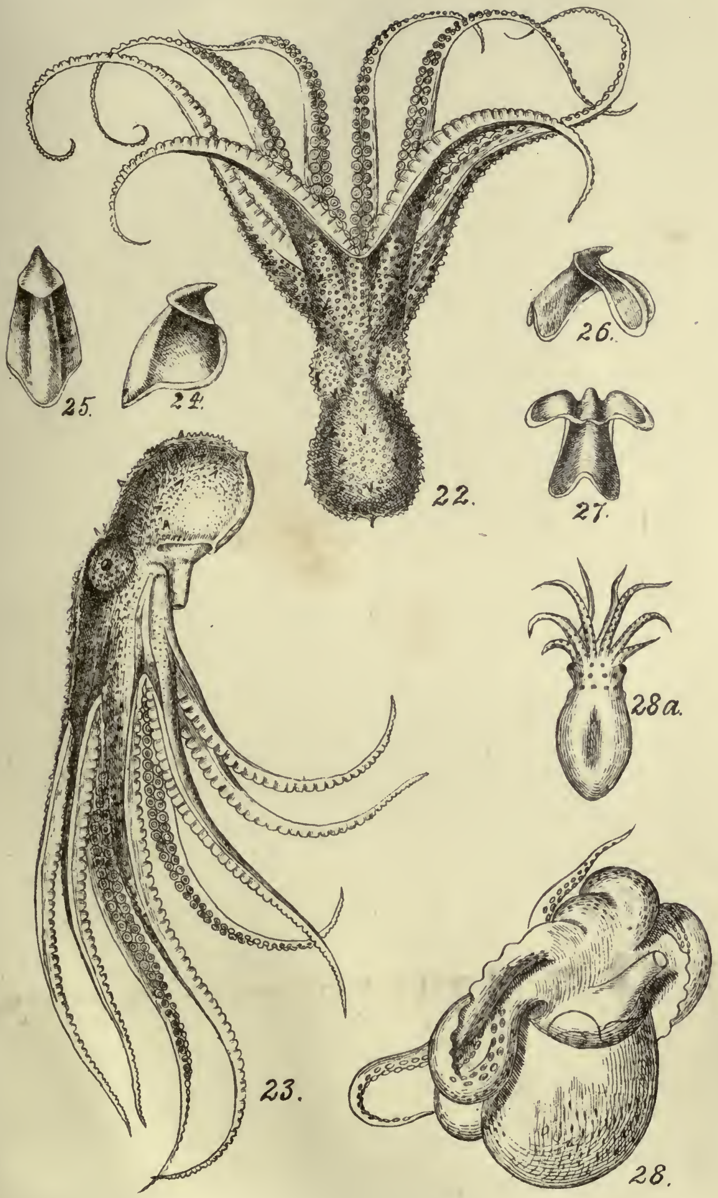
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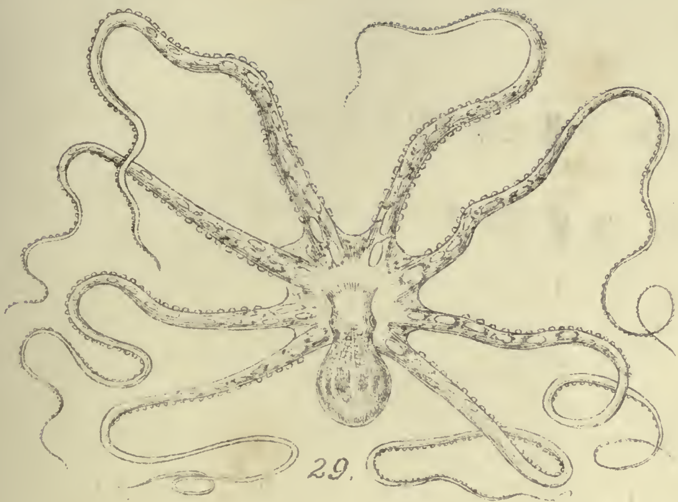

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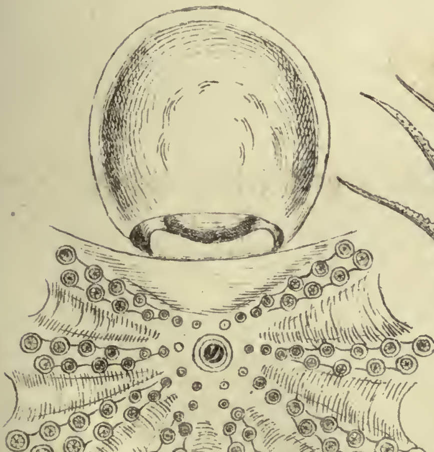

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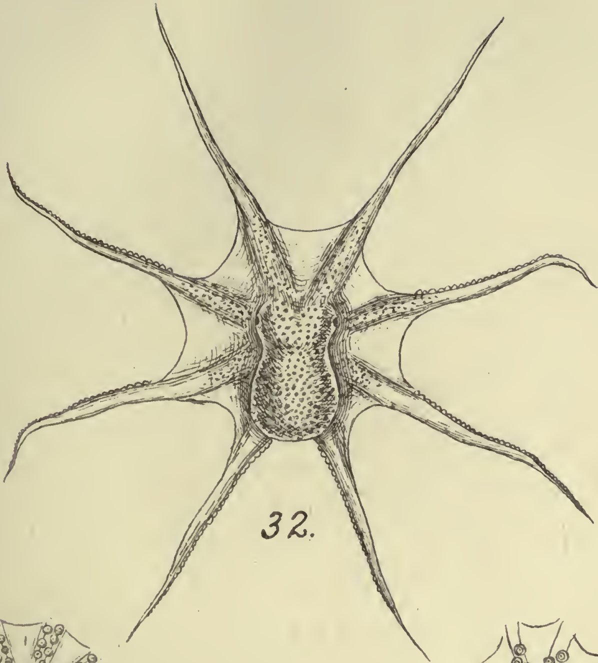

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two minutes after it had been captured by that animal, was already dead, although apparently uninjured either externally or internally.

The debris of the victims of the Poulpe, such as shells, carapaces of crustaceans, etc., accumulates in front of his retreat, which it serves to cover. The animal seizes portions of these by the suckers towards the base of his arms, and with them shields his body, only revealing the watchful eyes—the arms being thrown back on each side of his body.

A Poulpe may eat several shells and a crab daily, but if his supply fails, he will support an abstinence of some days.

The epidermis of the cups renews itself unceasingly, and is detached in entirety—above all after a meal. The water is filled with little transparent bodies in form like umbrellas, of which the disks are rayed—these are the rejected skins.

The slow movements of the Poulpe are very strange; it elevates its body and walks along on the recurved points of its arms, and without the assistance of its siphon. But in a large basin the Poulpe swims readily and without the awkwardness which I before remarked of its movements in an aquarium. Its rapid swimming is always retrograde; its body and arms maintain a horizontal position, the latter remaining absolutely passive; the siphon alone being used.

When the Poulpe swims, its color is a little different from that which it possesses when in repose, and I have frequently remarked a colored longitudinal ray starting from behind the eyes.

I have been a witness only once to the forward swimming of a Poulpe; it progressed very slowly, in truth. The arms, divided into two symmetrical bundles, were turned back on the body. This position is very unfavorable to swimming; the resistance of the water is much greater, and one can readily comprehend that the animal would use it rarely.

The number of respirations is variable, but much inferior to that of the Sepias: it averages from thirty to fifty in a minute. It is probable that in the sea the Poulpe respires much more slowly. In the aquarium respiration is accelerated by the vitiation of the water.*

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* Fischer, *Ann. Sci. Nat.*, 5 ser., viii, 97–104, 1867.

II. Octopi of enormous size are occasionally met with among the islands of the Meïa-co-shimah Group. I measured one, which two men were bearing on their shoulders across a pole, and found each brachium rather more than two feet long, giving the creature the power of exploring an area of about twelve feet without moving, taking the mouth for a central point, and the extremities of the arms, to describe the circumference. Dorsal plates of Sepiæ, a foot and a half in length, are found strewing the beaches. I have frequently observed the Sepiæ and Octopi in full predatory activity, and have had considerable trouble and difficulty in securing them, so great is their restless vivacity at this time, and so vigorous are their endeavors to escape. They dart from side to side of the pools, or fix themselves so tenaciously to the surface of the stones, by means of their sucker-like acetabula, that it requires great force and strength to detach them. When removed, and thrown upon the sand, they progress rapidly in a sidelong, shuffling manner, extending their long arms, ejecting their ink-like fluid in sudden, violent jets, and staring about with their huge shining eyes, which at night are luminous, like a cat's, in a very grotesque and hideous manner.—ARTHUR ADAMS.*

III. *Sepiola Atlantica*, Orb.—Respecting this species, Mr. Alder writes as follows from Menai Straits: "This is an odd fish, crouching generally at the bottom, like a toad, with its great goggle-eyes half-closed, and sometimes crawling along by means of its suckers, puffing the water through the funnel all the time. When it does take to swimming, it darts very quickly through the water and is difficult to catch. When taken out of the water and placed on the hand, it had recourse to an odd mode of progression, turning two or three somersaults in regular tumbler fashion; first laying hold with its arms, turning over, and laying hold again, until it managed to get back into the water.†

IV. I was much interested, on several occasions, by watching the habits of an Octopus or cuttle-fish. Although common in the pools of water left by the retiring tide, these animals were

* "Zool. Voy. Samarang," p. 1, 1850.

† "Report Brit. Assoc.," 73, 1852.

not easily caught. By means of their long arms and suckers, they could drag their bodies into very narrow crevices; and when thus fixed, it required great force to remove them. At other times they darted tail first, with the rapidity of an arrow, from one side of the pool to the other, at the same instant discoloring the water with a dark chestnut-brown ink. These animals also escape detection by a very extraordinary, chameleon-like power of changing their color. They appear to vary the tints according to the nature of the ground over which they pass; when in deep water, their general shade was brownish purple, but when placed on the land, or in shallow water, this dark tint changed into one of a yellowish green. The color, examined more carefully, was a French gray, with numerous minute spots of bright yellow; the former of these varied in intensity; the latter entirely disappeared and appeared again by turns. These changes were effected in such a manner, that clouds, varying in tint between a hyacinth-red and a chestnut-brown, were continually passing over the body. Any part being subjected to a slight shock of galvanism, became almost black: a similar effect, but in a less degree, was produced by scratching the skin with a needle. These clouds or blushes, as they may be called, when examined under a glass, are described as being produced by the alternate expansions and contractions of minute vesicles, containing variously colored fluids.

"This cuttle-fish displayed its chameleon-like power both during the act of swimming and whilst remaining stationary at the bottom. I was much amused by the various arts to escape detection used by one individual, which seemed fully aware that I was watching it. Remaining for a time motionless, it would then stealthily advance an inch or two, like a cat after a mouse, sometimes changing its color; it thus proceeded, till, having gained a deeper part, it darted away, leaving a dusky train of ink to hide the hole into which it had crawled.

"While looking for marine animals, with my head about two feet above the rocky shore, I was more than once saluted by a jet of water, accompanied by a slight grating noise. At first I did not know what it was, but afterwards I found out that it was the cuttle-fish, which, though concealed in a hole, thus often led me to its discovery. That it possesses the power of ejecting water, there is no doubt, and it appeared to me certain that it could, moreover, take a good aim by directing the tube or siphon on the under side of its body. From the difficulty which these animals have in carrying their heads, they cannot crawl with ease when placed on the ground. I observed that one which I kept in the cabin was slightly phosphorescent after dark."—*Charles Darwin.**

V. The ordinary resting-place of this hideous sea-beast is under a large stone, or in the wide cleft of a rock, where an Octopus can creep and squeeze itself with the flatness of a sand-dab, or the slipperiness of an eel. Its modes of locomotion are curious and varied; using the eight arms as paddles, and working them alternately, the central disk representing a boat, octopi row themselves along with an ease and celerity comparable to the many-oared caïque that glides over the tranquil waters of the Bosphorus; they can ramble at will over the sandy roadways, intersecting their submarine parks, and converting arms into legs, march on like a huge spider. *Gymnasts* of the highest order, they climb the slippery ledges, as flies walk up a window-pane; attaching the countless suckers that arm the terrible limbs to the face of the rocks, or to the wrack and sea-weed, they go about back downward, like marine sloths, or, clinging with one arm to the waving algæ, perform series of *trapeze* movements that Leôtard might view with envy.

I do not think, in its native element, an octopus often catches prey on the ground or on the rocks, but waits for them just as the spider does, only the octopus converts *itself* into a web, and a fearful one too. Fastening one arm to a stout stalk of the great sea-wrack, stiffening out the other seven, one would hardly know it from the wrack amongst which it is concealed. Patiently he bides his time, until presently a shoal of fish come gaily on. Two or three of them rub against the arms: fatal touch! As though a powerful electric shock had passed through the fish, and suddenly knocked it senseless, so does the arm of the octopus paralyze its victim; then winding a great sucker-clad cable round the palsied fish, draws the dainty morsel to the

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* Narrative of "Voyages of the Adventure and Beagle," iii, p. 6, 1839.

centre of the disk, where the beaked mouth seizes, and soon sucks it in.

I am perfectly sure, from frequent observations, the octopus has the power of numbing its prey; and the sucking-disks along each ray are more for the purposes of climbing and holding on whilst fishing, than for capturing and detaining slippery prisoners.

The Indian looks upon the octopus as an alderman does on turtle, and devours it with equal gusto and relish, only the savage roasts the glutinous carcase instead of boiling it. His mode of catching octopi is crafty in the extreme, for redskin well knows, from past experience, that were the octopus once to get some of its huge arms over the side of the canoe, and at the same time a holdfast on the wrack, it could as easily haul it over as a child could upset a basket. Paddling the canoe close to the rocks, and quietly pushing aside the wrack, the savage peers through the crystal water, until his practised eye detects an octopus, with its great rope-like arms stiffened out, waiting patiently for food. His spear is twelve feet long, armed at the end with four pieces of hard wood, made harder by being baked and charred in the fire: these project about fourteen inches beyond the spear-haft, each piece having a barb on one side, and are arranged in a circle round the spear-end, and lashed firmly on with cedar-bark. Having spied out the octopus, the hunter passes the spear carefully through the water until within an inch or so of the centre disk, and then sends it in as deep as he can plunge it. Writhing with pain and passion, the Octopus coils its terrible arms round the haft; redskin, making the side of his canoe a fulcrum for his spear, keeps the struggling monster well off, and raises it to the surface of the water. He is dangerous now; if he could get a holdfast on either savage or canoe, nothing short of chopping off the arms piecemeal would be of any avail.

But the wily redskin knows all this, and has taken care to have another spear unbarbed, long, straight, smooth, and very sharp, and with this he stabs the octopus where the arms join the central disk. I suppose the spear must break down the nervous ganglions supplying motive power, as the stabbed arms lose at once strength and tenacity; the suckers, that a moment before held on, with a force ten men could not have overcome, relax, and the entire ray hangs like a dead snake, a limp, lifeless mass. And thus the Indian stabs and stabs, until the octopus, deprived of all power to do harm, is dragged into the canoe, a great, inert, quivering lump of brown-looking jelly.—LORD.*

VI. Indian women are reported to have been drowned by being clasped by huge Octopods whilst bathing in the Pacific, on the coasts of British America, and among the Indians are traditions of narrow escapes. There is also a tradition among the Chimsgau Indians that about seventy years ago a two-masted vessel, with an oriental crew aboard, was seized (at Milbank Sound, lat. 52°) by an enormous squid, and was only rescued by chopping its tentacles with axes. The Indians add that the "evil influence" of the squid caused the subsequent wreck of the vessel at a point further south on the coast.—G. M. DAWSON, in *Nature*.

The newspapers frequently contain accounts of the encounters of submarine divers with gigantic cephalopods; the following is a recent instance:

A DIVER AND A DEVIL-FISH.—The diver engaged at the Moyne River, Belfast, in removing the reef, had a narrow escape from losing his life on Thursday. It appears that Mr. Smale had fired off a charge of dynamite and displaced a large quantity of stones at the bottom of the river. He went down to prepare for lifting these stones by the aid of chains into the punt. While engaged in rolling over a large stone he saw something which he supposed at the time was a piece of clean-looking kelp moving about in front of where he was working. In a few seconds the object came in contact with the diver's arm, about which it quickly coiled, partly holding him. Immediately Mr. Smale touched what was coiled around his arm he became aware of his position, and tried to extricate himself from the grasp of a "sea-devil," but found it far more difficult than he anticipated. Catching hold of the part hanging from the arm, he walked along the bottom of the river toward the end of it, when he saw he was firmly held by one of the feelers of a large Octopus, better known among sailors as the "devil-fish." Mr. Smale tried to pull the

* "The Naturalist in British Columbia," i, 192, 1866.

fish off from his hold on the rocks, but without effect for some time. At last the fish, perhaps thinking it had not got sufficient hold or power upon its prey, loosened itself from the stones and quickly transferred its feelers or arms around the diver's legs and body. In this position Smale thought the best thing for him to do was to get up on deck as soon as possible, and he quickly made for the ladder which reaches from the deck of the punt to the bottom of the river. The diver was certainly a curious looking object when he came up. This huge, ugly looking thing appeared to be entangled all over him, holding him in a firm embrace. However, Mr. Smale's fellow-workmen were not long in freeing him from the unfriendly hug of his submarine companion. The body portion of the Octopus was only about the size of a large soup-plate, with eyes in its head like those of a sheep, but it possessed nine arms, each about four feet in length, at the butt as thick as a man's wrist, tapering off at the end to as fine a point as that of a penknife; thus it could spread over an area of 9 feet in diameter. All the way along the underneath part of each feeler are suckers every quarter of an inch, giving it immense power. Mr. Smale declares it was powerful enough to keep three men under water.—*Warrnambool (Australia) Standard*, 1878.

VII. Lucie L. Hartt thus relates her experience with an Octopus:

It was during my first visit to Brazil, that one day, while busily engaged in examining a reef at a little town on the coast called Guarapary, my eye fell on an object in a shallow tide-pool, packed away in the crevice of the reef, which excited my curiosity. I could see nothing but a pair of very bright eyes; but, concluding that the eyes had an owner, I determined very rashly to secure him. I had been handling corals, and seemed to have forgotten that all the inhabitants of the sea are not harmless. I put my hand down very quietly so as not to ruffle the water, when, suddenly, to my surprise, it was seized with a pressure far too ardent to be agreeable, and I was held fast. I tugged hard to get away, but this uncivil individual, whoever he was, evidently had as strong a hold on the rocks as he had on my hand, and was not easily to be persuaded to let go of either. At last, however, he became convinced that he must choose between us, and so let go his hold upon the rocks, and I found clinging to my right hand, by his long arms, a large octopod cuttle-fish, and I began to suspect that I had caught a Tartar. His long arms were wound around my hand, and these arms, by the way, were covered with rows of suckers, somewhat like those with which boys lift stones, and escape from them was almost impossible. I knew that this fellow's sucking propensities were not his worst ones, for these cuttle-fishes are furnished with sharp jaws, and they know how to use them too, so I attempted to get rid of him. But the rascal, disengaging one slimy arm, wound it about my left hand also, and I was a helpless prisoner. In vain I struggled to free myself—he only clasped me the tighter. In vain I shouted to my companion—he had wandered out of hearing. I was momentarily expecting to be bitten, when the "bicho" suddenly changed his mind. I was never able to discover whether he was smitten with remorse and retired with amiable intentions, or whether he only yielded to the force of circumstances. At any rate he suddenly relinquished his hold upon my hands and dropped to the sand. Then raising himself on his long, limsy arms, he stalked away towards the water, making such a comical figure, that, in spite of my fright, I indulged in a hearty laugh. He looked like a huge and a very tipsy spider, staggering away on his exceedingly long legs.

Cuttle-fishes are sometimes used for food by the Brazilians, and different species may be seen in the markets, where one frequently finds them still alive. Sometimes, as he stoops to examine one, its body is suddenly suffused with a deep pinkish glow. Before he has time to recover from his surprise, this color fades, and a beautiful blue takes its place as rapidly as a blush sometimes suffuses a delicate cheek. The blue, perhaps, is succeeded by a green, and then the whole body becomes pink again. One can hardly conceive anything more beautiful than this rapid play of colors, which is produced by the successive distention of sets of little sacks containing fluids of different colors, which are situated under the skin.*

* Lucie L. Hartt, in *American Naturalist*, iii, 256, 1870.

VIII. *Habits of Octopus vulgaris.*—Into one of my cages I had put a living *Pinna nobilis* adhering to a fragment of rock; this cage also contained an *Octopus vulgaris*, and some living testaceous mollusca which I had placed there for the purpose of my investigations. One day, whilst observing my animals, I saw that the Poulpe was holding a fragment of rock in one of its arms, and watching the *Pinna*, which was opening its valves; as soon as they were perfectly open, the Poulpe, with incredible address and promptitude, placed the stone between the valves, preventing the Pinna from closing them again, when the Octopus set about devouring the mollusk.

The next day I was observing the Poulpe again, when I saw him crush some Tellinæ, then search about amongst other shells, and finally stretch himself close to a *Triton nodiferum.* I had the perseverance to remain on the watch for four hours. The Triton extruded half the body from its shell, no doubt with the purpose of going to seek its food, when the Poulpe sprang upon it, and surrounded it with his arms; the mollusk retired precipitately into its shell, and in closing this with its operculum, pinched the point of one of the arms of the Poulpe, which, by struggling, at last left the tip of his arm in the shell of the Triton. It would require whole pages to describe all the stratagems employed by the Poulpe for the capture of his prey. I should have to tell things which would appear incredible; and his voracity is such, that notwithstanding the abundance of nourishment with which I furnished him, I was compelled to remove him from the cage, or he would have devoured all my mollusca. So great is its voracity, that it even attacks man, tears away his flesh, and eats it.—MADAME J. POWER.*

It may be remarked upon the above account, that the particular Poulpe observed by Mad. Power, completely falsified the axiom that " nature works by the simplest means," by using an *intelligent* method of overcoming the resistance of the Pinna, when the latter's fragile laminated shell lay at the mercy of the powerful jaws with which he is endowed. The muscular power of the arms of the Poulpe is probably quite sufficient, moreover to crush the shell of the Pinna, if the two animals are equally

* *Ann. Mag. N. Hist.*, 2d ser., xx, 336, 1857.

of normal proportions. The Triton, like most of the active predaceous mollusks, possesses an operculum scarcely adapted by its size to close the aperture of its shell. It is possible that by continued contraction, the animal might expel the water from its body, sufficiently to retire within the whorls until the operculum would touch its walls, but normally, it does nothing of the kind; and it would certainly require an appreciable period of time to accomplish it. Had the Poulpe possessed as much patience and endurance as cunning, it would have suffered the imprisonment of its member for a short period, until the relaxation of the operculum of the gasteropod, the strain of which only endures under opposition. As the Poulpe in the stone dodge related above shows no higher intelligence than monkeys, who are said to catch their shell-fish in the same manner, it is a pity that Madame Power did not describe *some* of the "stratagems employed by the Poulpe for the capture of his prey," which, to use her words, "would appear incredible."

Gigantic Cephalopods: historical and fabulous.

I. *Mediterranean Species.**—Aristotle speaks of a cephalopod about 6½ feet long, belonging to the division of the Calamaries. It is the same species which is mentioned in the fables of Pliny, in Œlian, in Strabo, in Aldrovandi, etc.

Pliny obtained the history of this creature from Trebius Niger, one of the lieutenants of L. Lucullus in Spain. He relates that, every night, the Calamary came to the shore to carry off the fishes placed in the brine by the fishermen. The animal was of monstrous size; it dispersed the dogs by its redoubtable breath; sometimes it struck them with the ends of its feet; sometimes it used against them its two long arms, which were so strong that their blows resembled those of a club; at last it was killed by means of several tridents. Its head was shown to Lucullus; it was the size of a tun, having the capacity of 15 amphoræ. Its arms and feet were also shown to him; their size was such that a man could scarcely embrace them; they were knotty like clubs

* I am indebted for a portion of the material of this chapter to a curious and valuable paper by Messrs. Crosse and Fischer, published in *Journal de Conchyliologie*, ii, 124, 1862.

and 30 feet long. The cavities with which they were strewn resembled basins and could contain the quantity of a jar. The teeth corresponded with its size. They kept what remained of its body as a marvelous thing, and it weighed 700 pounds. It is evident from this exaggerated statement of Pliny that he speaks of a decapod, which is proven by the distinction he makes between its feet and its two major arms. Besides, Pliny speaks of the size of its suckers without mentioning any claws. All these details confirm our opinion, and we think that Pliny's animal is related to the Calamaries and the Ommastrephians.

The fishermen of Cette captured a cephalopod nearly 6 feet long and which forms part of the Collection of Montpellier. M. Steenstrup has recognized in it a species described by him as *Ommastrephes pteropus.* The same species exists in the Museum at Copenhagen, after having formed part of the cabinet of M. Eschricht, who obtained it at Marseilles. This specimen is the type of Steenstrup's description.

The Museum at Trieste possesses an analogous animal found on the Dalmatian coast; and, finally, M. Vérany cites a Calamary about $5\frac{1}{2}$ feet long. These numerous facts do not permit us to doubt the existence in the Mediterranean of very large cephalopods of the genus Ommastrephes. The development of the fin and of the veliform membrane of the third pair of arms induces us to believe that these animals only inhabit the high seas and that they are very good swimmers; which explains their rarity in collections.

As to Octopus, its size can attain a very remarkable development. Vérany speaks of one that he had seen at Nice, over 9 feet in length and weighing 35 pounds.

Frédol, in "Le Monde de la Mer," states that the famous diver, Piscinola, who, at the desire of the Emperor Frederick II, dived in the Straits of Messina, saw, with much alarm, enormous poulps attached to the rocks, their arms several yards long, quite capable of destroying a man.

II. *Of the great Cephalopods of the Northern Seas.*—The traditions of the North are full of the existence in those regions of an immense animal, the Kraken, which occupies the first rank by its size ("The largest animal in the world."—PONTOPPIDAN, 394, t. 2), and which more resembles an island than an organized being.

It would be tiresome to enumerate all the marvelous stories which have been debited to its account; but the impression which they have made on the minds of the Northern naturalists has been sufficiently great to determine Linnæus to accord the Kraken a place in his Fauna Suecica, as well as in his Systema (*Sepia microcosmos*). Bosc has followed the example of Linnæus, and the Kraken has become to his eyes a sort of cuttle-fish. Montfort has taken care to make of it a being different from his Colossal Poulpe.

We know at present what degree of confidence can be accorded to Pontoppidan, who is entirely responsible for the invention of the sea-serpent, and who hesitates not, as well as Montfort. his imitator, to make figures to support his fantastic descriptions; but it is not the less certain that very large cephalopods have been taken in the Northern Seas.

Früs speaks of a colossal Poulpe caught in the rocks of the Gulf of Ulwangen, in 1680.

Steenstrup communicated to the reunion of Scandinavian naturalists held in 1847, information concerning two gigantic cephalopods captured, in 1639 and 1790, on the coast of Iceland.

In 1856, M. Steenstrup gave some observations on a cephalopod thrown upon the coast of Jutland. The body of the animal, cut up by the fishermen for bait, furnished the contents of several wheelbarrows, and the pharynx, which has been preserved, was of the size of an infant's head.

The cephalopod of Jutland and those of Iceland belong to the Calamary type. The first has received the name of *Architeuthis dux;* the two others are designated provisionally by M. Steenstrup under the name of *Architeuthis monachus.*

It is probable that the stump of an arm shown by Steenstrup to M. A. Duméril, the size of which equaled that of a man's thigh, belonged to *Architeuthis dux.**

In the vaults of the British Museum there has been long preserved a single arm of a huge cephalopod, measuring from one end to the other no less than nine feet; the circumference at its

* *Compt. Rend.*, 1861.

base is eleven inches; and thence it gradually tapers off, terminating in a fine point. The suckers, which cover the whole of the under surface of this arm, are distributed in two alternating rows, numbering from 145 to 150 suckers to each row: those at the base having a diameter of half an inch, and gradually decreasing in size as they approach the attenuate extremity. No authenticated record of the circumstances attending the capture of this remarkable specimen, or of the locality whence obtained, appears to have been preserved; but it is believed to have come from the South American coast.* "It may be an arm of *A. princeps* or of *Loligo Hartingii,* or it may appertain to the Loligo Bouyeri of Crosse and Fischer."—VERRILL, *Am. Naturalist*, ix, 86.

Harting has described portions of two enormous cephalopods in the University Museum of Utrecht. Their habitat and circumstances of their capture are unknown. The first and largest M. Harting identifies with *Architeuthis dux* Steenst. The buccal parts, some cups and the dentition are preserved.†

The following is from *The Zoologist*, June, 1875:

CAPTURE OF AN ENORMOUS CUTTLE-FISH OFF BOFFIN ISLAND, ON THE COAST OF CONNEMARA (IRELAND).—On Monday last, the crew of a curragh,‡ consisting of three men, met with a strange adventure northwest of Boffin Island. Having shot their spillets (or long lines) in the morning, they observed to seaward a great floating mass, surrounded by gulls; they pulled out, believing it to be a wreck, but, to their great astonishment, found it to be a cuttle-fish of enormous proportions, and lying perfectly still, as if basking on the surface of the water. A knife was the only weapon on board. The cuttle is much prized as a bait for coarse fish, and the crew resolved to secure at least a portion of it. Considering the great size of the monster, and knowing the crushing and holding powers of the arms, open hostility could not be resorted to, and the fishermen shaped their tactics differently. Paddling up with caution, a single arm was suddenly

* This arm is more carefully described in "Zool. Proc.," 493, 1874, and identified with *Ommastrephes todarus*, supposed to be the same as *Architeuthis dux* of Steenstrup.

† P. Harting, "Verh. Akad. Weten.," Amsterdam, ix, t. 1, 2, 1861.

‡ A large kind of coracle made with wooden ribs, and covered with tarred canvas.

seized and lopped off. The cuttle, hitherto at rest, became dangerously active now, and set out to sea at full speed in a cloud of spray, rushing through the water at a tremendous rate. The canoe immediately gave chase, and was up again with the enemy after three-quarters of a mile. Hanging on the rear of the fish, a single arm was attacked in turn, while it took all the skill of the men to keep out of the deadly clutch of the suckers. The battle thus continued for two hours, and while direct conflict was avoided, the animal was gradually being deprived of its offensive weapons. Five miles out on the open Atlantic, in their frail canvas craft, the boatmen still slashed away, holding on boldly by the stranger, and steadily cutting down his powers. By this time the prize was partially subdued, and the curragh closed in fairly with the monster. Such as remained of the ten great arms slashed around through the air and water in most dangerous but unavailing fashion. The trunk of the fish lay alongside, fully as long as the canoe, while in its extremity, the mutilated animal emitted successive jets of fluid, which darkened the sea for fathoms around The head at last was severed from the body, which was unmanageable from its great weight, and sank like lead to the bottom of the sea. Of the portions of the mollusk taken ashore, two of the great arms are intact, and measure 8 feet each in length, and 15 inches round the base. The two tentacles attain a length of 30 feet. The mandibles are about 4 inches across. The head, devoid of all appendages, weighed about 6 stone, and the eyes were about 15 inches in diameter.

It is evident, from the supine condition of this monster, that it was very sick or in a dying condition when attacked; otherwise, it would have escaped capture readily by diving. Certain exaggerations in the above account are probably due to the ignorance rather than invention of the captors.

In a further account of this animal,* Mr. A. G. More states that:

The tentacles were 30 feet long when fresh (14 and 17 feet can still be made up from the pickled pieces), and a short arm measured 8 feet in length, by 15 inches around the base. The

* *Annals and Mag. of Nat. Hist.*, 4th ser., xvi, 123.

club of the tentacle, nearly 3 feet in length, is occupied in the centre of the palm by two rows of large stalked suckers, nearly 1 inch in diameter, fourteen in each row; an alternating row of fourteen smaller suckers (½ in. diam) occupies the margin on each side of the palm; these outer suckers had each a denticulated bony ring of about twenty-eight teeth, pointing inwards (the rings of the large inner suckers had probably been removed or fallen out before the specimens were examined). Just beneath where the large suckers end, there is a cluster of very small ones arranged closely in six transverse rows, and the extremity of the club has also a great number of small suckers, whilst a few nearly sessile ones are scattered on the inner surface of the peduncle. Most of these had no denticulations on the rings. The beak has a wide, strong tooth about the middle of the edge of the upper mandible, and a much narrower notch on the outer mandible, on each side. These specimens are now in the Museum of the Royal Society, at Dublin.

In a collection of rare tracts relating to Irish history which was formed by a London bookseller named Thomas Thorpe, and is now deposited in the library of the Royal Dublin Society, there is a most curious record of the occurrence of an enormous cuttle-fish. The first three letters and the description are all printed, together with a rude drawing, upon the same side of one broad sheet, "printed in London for Francis Smith, at the Elephant and Castle near the Royal Exchange in Cornhill." The fourth letter is in manuscript, and the second broadsheet or advertisement was evidently printed in Dublin, so as to be distributed in the form of a handbill.

The drawing represents a cuttle-fish with broad ovate body covered by a loosely-folded mantle. A pointed extremity, or tail, with what appears like the two lobes of a fin, is shown as projecting beyond the mantle. The head bears two enormous eyes, and above them rise on each side the eight short arms, each bearing two rows of suckers along their entire length. In the centre are seen the two longer arms or tentacles, which are drawn as thick as the rest, and are quite bare and smooth, with no suckers, tapering outwards into a point, as if the club, or expanded portion, had been torn off. But the most extraordinary feature is the so-described extensible proboscis, which is represented as rather thicker than the tentacular arms and is slightly expanded at the top, swelling into a small rounded knob or "head," upon which two small eyes are roughly indicated, and which bears the mandibles. So circumstantial is the account given by the different persons concerned, and the minute details appear in the main to be so like truth, that I do not see why the extensible proboscis should not be accepted as correct, though of course the little eyes may have been added as ornaments by the enterprising showman. This character, if real, must necessarily be of generic value, and I think that our Kerry "monster," not having yet received a scientific name, may very well be designated as *Dinoteuthis proboscideus*.*

Appended to the above are several letters, dated 1673, from persons who had seen the cuttle and who describe it, with particulars of its capture. I extract the following description:

"This monster was taken at Dingle-I-cosh in the County ot Kerry, being driven up by a great storm in the month of October last, 1673; having two heads, one great head (out of which sprung a little head two foot or a yard from the great head) with two great eyes, each as big as a pewter dish, the length of it being about nineteen foot, bigger in the body than any horse, of the shape represented by this figure, having upon the great head ten horns, some of six some of eight or ten, one of eleven foot long, the biggest horns as big as a man's leg, the least as his wrist, which horns it threw from it on all sides. And to it again to defend itself having two of the ten horns plain, and smooth that were the biggest and middle horns, the other eight had one hundred crowns a-piece, placed by two and two on each of them, in all 800 crowns, each crown having teeth, that tore anything that touched them, by shutting together the sharp teeth, being like the wheels of a watch. The crowns were as big as a man's thumb or something bigger, that a man might put his finger in the hollow part of them, and had in them something like a pearl or eye in the middle; over this monster's back was a mantle of a

* The extensible "proboscis" is a character common to the immense cephalopods of the North Atlantic, and the eyes situated upon it, were added, of course, "by the enterprising showman."—G. W. T., Jr

bright red color, with a fringe round it, it hung down on both sides like a carpet on a table, falling back on each side, and faced with white, the crowns and mantle were glorious to behold: This monster had not one bone about him, nor fins nor scales, or feet, but had a smooth skin like a man's belly. It swoom by the lappits of the mantle; the little head it could dart forth a yard from the great, and draw it in again at pleasure, being like a hawk's beak, and having in the little head two tongues, by which, it is thought, it received all its nourishment: when it was dead and opened, the liver wayed thirty pounds. The man that took it came to Clonmel the fourth of this instant December, with two of the horns in a long box with the little head, and the figure of the fish drawn on a painted cloth, which was the full proportion of it, and he went up to Dublin, with an intent to shew it to the Lord Lieutenant."

The advent of this animal is thus described in a letter from Thomas Hooke (Dublin) to Mr. John Wickins (London), December 23d, 1673:

"That in the month of October last, I think about the 15th day, he was alone riding by the seaside, at Dingle-I-cosh, and saw a great thing in the sea, which drew his eye towards it, and it came just to him; when he discerned the horns, it began to look frightfully; he said he was sometimes afraid to look on it, and when he durst look on it, it was the most splendid sight that he ever saw; the Horns were so bespangled with those Crowns, as he calls them; they shewed, he saith, like Pearls or precious Stones; the Horns it could move and weild about the Head as a Snail doth, all the ten; the two long ones it mostly bore forwards, the other eight mov'd too and fro every way; when it came to shore its fore parts rested on the shore, and there lay; He got help after awhile, and when he saw it stirred not to fright them, he got ropes and put them about the hinder parts, and began to draw it on shore, and saw it stirred not to hurt them, they grew bold, and went to pull with their hands on the Horns, but these Crowns so bit them, that they were forced to quit their hold: the crowns had teeth under every one of them, and had a power to fasten on anything that touched them; they moved the Horns with handspikes, and so being evening they left it on the shore, and came in the morning and found it dead."

A letter from a "very Sober person in Dublin" mentions that "The head was not soe bigg as my fist, the mouth and two hard shells upon it very black and shap'd like to an Eagle's Bill, but broader; in the mouth there was two tongues, and (as the Man declared that tooke this monster) the Beast had naturall power to draw this head in or putt it out of the Body as necessity required."

Such are the essential portions of a communication made by Mr. A. G. More, F. L. S., to *The Zoologist* (page 4526, 1875). Whether the "Monster" shall be classified on the faith of Mr. More, as a new cephalopod, or whether it would be better arranged among the Irish Bulls as a marine form thereof, I leave to the discrimination of my readers. Mr. Verrill, who is good authority, thinks it is *Architeuthis monachus* Steenstrup.

The *American Sportsman* for Dec. 6th, 1873, contains a well-authenticated account of a huge cephalopod lately encountered in Conception Bay, Newfoundland, one of the longer arms of the same having been secured and deposited in the St. John's Museum. The full description of the monster as contributed by the Rev. M. Harvey, of St. John's, may be thus condensed:

Two fishermen while plying their vocation off Great Belle Island, Conception Bay, Oct. 26th, 1873, suddenly discovered, at a short distance from them, a dark shapeless mass floating on the surface of the water. Concluding that it was probably part of the cargo of some wrecked vessel, they approached, anticipating a valuable prize, and one of them struck the object with his boat-hook. Upon receiving the shock the dark heap became suddenly animated, and showed an intelligent face, with a pair of large prominent ghastly eyes, which seemed to gleam with intense ferocity, the creature at the same time exposing to view, and opening, its parrot-like beak with an apparently hostile and malignant purpose. The men were petrified with terror, and for a moment so fascinated by the horrible sight as to be powerless to stir. Before they had time to recover their presence of mind, the monster, now but a few feet from the boat, suddenly shot out from around its head several long arms of corpse-like fleshiness, grappling with them for the boat and seeking to envelop it in their folds. Only two of these reached the craft, and, owing to their length, went completely over and beyond it. Seizing his hatchet with a desperate effort, one of the men succeeded in severing these limbs with a single well-delivered blow; and the creature finding itself worsted, immediately disappeared beneath the waters, leaving in the boat its amputated members as a trophy of the terrible encounter. One of the arms was unfortunately destroyed before its value was known; but the other, when brought to St. John's and examined by the Rev. M. Harvey, was found to measure no less than 19 feet; and the fisherman who acted as surgeon declares there must have been at least 6 feet more of this arm left attached to the monster's body. This separated member is described by Mr. Harvey as being livid in color and pointed at its extremity, where alone it is covered with rows of cartilaginous horny suckers, each about the size of a quarter-dollar. Unfortunately, the fishermen were too much frightened during the short time the adventure lasted to form a reliable opinion of the length of the animal's body; under the influence of terror they set it down at 40 feet, an estimate which, notwithstanding the extraordinary dimensions of the arm secured, must be received as a considerable exaggeration.*

Rev. Mr. Gabriel states that in the winter of 1870–71 two cuttle-fish were stranded on the beach near Lamalein, south coast of Newfoundland, which measured respectively 40 and 47 feet.

Mr. Murray refers also to a specimen caught at Logia Bay, near St. John's, Newfoundland, November, 1873, which measured as follows: Body, 7 feet long; circumference, 5 feet; tail, fan-shaped, pointed at middle extremity, 2 feet; large arms, 6 to 7 feet long, and 7 to 9 inches circumference, covered on the lower surface with about 100 denticulated cups; tentacles, 24 feet long and 3 inches circumference, with the clubs armed with about eighty denticulated suckers.

A very respectable person informs me that he has seen many of these gigantic squids upon the coast of Labrador; and that he measured the body of one 80 feet from beak to tail. He also states that a certain Mr. Haddon, a school inspector of this place

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* W. S. Kent, *Zool. Proc.*, 178, 1874. Other accounts of this animal may be found in *Am. Naturalist*, viii, 120, 1874; *Proc. Bost. Soc. N. H.*, xvi, 161, 1873.

measured one 90 feet. He tells me, moreover, that the monsters are edible.*

Quite a literature has been accumulated within the past few years upon the gigantic cephalopods of Newfoundland, the occurrence of which has become rather frequent. The above extracts will enable our readers to form some idea of the size and appearance of these monsters. Further particulars may be obtained by those interested, from the papers of Messrs. Hyatt and Verrill, in the *American Naturalist* and *American Journal of Science.*

The Great Cephalopods of the Pacific.—Dom Pernetty ("Voyage aux iles Malouines, ii, 76) thus expresses himself on the subject of a cephalopod:

"In the opinion of the sailors of the South Seas, the Cornet is the largest fish of the ocean. The seamen say also that they attach themselves and grapple with vessels. Our captain and his brother, who have made several voyages on the southern seas, have also assured me of this fact, but they added that they had not seen them of this size, but had eaten of some of 150 weight or thereabouts."

Molina† echoes Pernetty when, apropos to his *Sepia tunicata*, he says: "The sailors exaggerate the size and strength of this animal; but it is sure that those taken in the seas of Chili do not weigh less than 150 pounds. To exhaust our incomplete information concerning these animals, it is mentioned in the *Jour. de Phys.*, ii, 1784, that a South Sea whaler in 1783 captured a Balæna, in the mouth of which was found the arm of a Poulpe 27 feet long, and thick as a ship's mast. The Balæna is known to live almost entirely, however, on very small pteropods; it is the dolphin and the cachalot which feed on cephalopods."

In the second voyage of Capt. Cook,‡ it is related that after having doubled Cape Horn, "Mr Banks found a great Sepia which appeared to be slain by the birds; its mutilated body floated on the water; it was very different from the cuttle-fish

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* *Am. Nat.*, viii, 120, 1874.

† "Hist. Nat. Chili," 173, 1789.

‡ ii, 301.

which are found in the European seas, for its arms, instead of suckers, were armed with a double range of claws, very sharp, resembling those of the cat, and which it could, like that animal, withdraw at will." Parts of this mollusk having been sent to London, and placed in the Museum of the College of Surgeons, Owen examined them. He says: "The fins have a rhomboidal form, which allowed the animal to swim both forwards and backwards." Comparing it with smaller specimens of the same species, and allowing a similar proportion for its arms, the entire animal must have exceeded 7 feet, its body being at least 4 feet in length.

D'Orbigny recognized in this mollusk the distinctive characters of his genus Enoploteuthis, and he called it *E. Molinæ*.

Is it the same animal which Péron saw, and of which he too briefly speaks in his "Voyage" (i, 18)? "The same day (Jan. 9), not far from the island of Van Diemen, we perceived on the waves, at a little distance from the vessel, an enormous species of Sepia, probably a Calamary, of the size of a tun. It rolled noisily in the midst of the waves, and its large arms sprawling to their surface were agitated like enormous reptiles. Each of these arms was not less than 6 or 7 feet in length, by a diameter of 7 or 8 inches."

Prof. Brewer, of Yale College, has seen Octopi measuring 14 feet from tip to tip of the expanded arms, in the San Francisco markets.*

In the winter of 1871–2, at Ilinlink, Unalashka, a large number of giant cuttles were stranded at various times. One of these, a species, apparently, of Pinnoctopus, measured 6 feet from tip to tip of the arms. The color was white, ocellated with brick-red, and the larger suckers measured 25 inches across.†

A still more remarkable form, however, was subsequently obtained, perhaps the *Onychoteuthis Bergi* Licht, one specimen of which measured, from the posterior end of the body to the mutilated ends of the tentacular arms, 110 inches, with a body-girth of 3 feet, and weighing nearly 200 pounds. Another specimen more mutilated measured 80 inches in length. The larger

* *Am. Nat.*, vii, 94, 1873.

† There is evidently a mistake in measurement of the suckers; perhaps millimetres, instead of inches, is intended.

one could hardly have been less than 10 feet long when perfect, the pen measuring 61 inches. The *Octopus punctatus* Gabb, which occurs at Sitka abundantly, reaches a length of 16 feet or a radial spread of nearly 28 feet, but the whole mass is much smaller than that of the decapodous cephalopods of lesser length. In the Octopus above mentioned, the body would not exceed 6 inches in diameter and a foot in length, and the arms attain an extreme tenuity toward their tips.

There can be no doubt whatever that some cephalopods in the warmer seas attain an enormous bulk as well as length. Capt. E. E. Smith, an experienced sperm-whaler, and a careful and intelligent observer, informs me that he has seen portions of "squid" arms vomited up by whales in their death-agony, as large as a "beef-barrel," with suckers on them "as big as a dinner-plate." I have no doubt of the correctness of this statement.—W. H. Dall, *Am. Naturalist*, vii, 484, 1873.

It seems that the celebrated "Kraken" of Denys Montfort has wandered into the Central Pacific Ocean, for Mr. Dall, in the above article, states that Mr. Henry G. Hanks saw, when on a voyage in a trading schooner among the South Sea Islands, a cuttle-fish, near the surface of the water, "as large as the schooner!" Mr. Dall naïvely adds, "while this is rather indefinite, still it indicates that specimens much larger than any yet recorded may probably exist in those regions."

In the "Mittheilungen der Deutschen Gesellschaft von Yokohama, Japan," May, 1873, is an account of a large *Ommastrephes* found in the Japanese Seas. Its dimensions are:—

Length of body to front edge of mantle . .	6 feet.
Length of head and neck	1½ feet.
Longest arm	6½ feet.

The Great Cephalopods of the Middle Atlantic.—It is to be remarked that Denys Montfort relates several combats with gigantic Poulpes encountered near the African coast. The positive presence to-day of these animals in the same seas, leads one to believe that these fables had a foundation in fact. One can see at Saint Malo, in the chapel of St. Thomas, says our credulous naturalist, an ex-voto representing the danger incurred by a ship of this port whilst anchored on the coast of Angola. A Poulpe of dreadful dimensions attached itself to the vessel and attempted to sink it. Grandpré, author of a voyage to Africa, certifies to the existence of monstrous Poulpes at a certain distance from the land. Another sailor, Jean Magnus Dens, was, according to Montfort, attacked by a gigantic "Encornet" during the passage between the island of St. Helena and Cape Negro.

Leaving these suspicious documents for the relations of those more worthy of confidence, we find the following in Quoy and Gaimard ("Voy. Uranie" I, 2d Part, 411):

In the Atlantic Ocean, near the equator, we collected the remains of an enormous Calamary. What was left of it might weigh 100 pounds, and it was but a longitudinal moiety deprived of its tentacles, so that one can without exaggeration assign the weight of 200 pounds to the entire animal.

Rang ("Manuel des Moll.," 86) is not less explicit. We have encountered in the middle of the ocean, a species quite distinct from the others, of a very dark red, having short arms, and the size of a tun.

Mr. J. S. George, of Nassau, N. P., Bahamas, mentions that a monster Octopus was found dead upon the beach. It was 10 feet long, each arm measuring 5 feet; the weight was estimated at between 200 and 300 pounds. Mr. George adds "this is the first specimen I have seen during twenty-seven years' residence in Bahamas, but they are known here traditionally of immense size.*

On the 30th of November, 1860, the French steamer Alecton, commanded by Lieut. Bouyer, encountered, between Madeira and Teneriffe, an enormous Poulpe, which was swimming on the surface of the water. The animal measured 15 to 18 feet in length, without counting the formidable arms, covered with cups, which crowned its head. Its color was brick-red; its eyes had a prodigious development and frightful fixity. Its mouth, like the beak of a parrot, could be opened to the extent of 18 inches. Its body, fusiform but much swelled towards the centre,

* *Am. Naturalist*, vi, 772, 1872.

presented an enormous mass, the weight of which has been estimated at more than 4400 pounds. Its fins, situated at the posterior extremity, were rounded in two fleshy lobes and of very large size. The commander of the vessel on perceiving it, halted upon his course and made preparations for capturing the monster. Guns were charged and harpoons hastily prepared; but at the first discharge of the former, the animal dived under the ship and immediately appeared on the other side. Attacked again with harpoons, it disappeared two or three times, and, each time that it reascended to the surface, its long arms writhed. The ship followed or arrested its course according to the movements of the animal. This chase lasted more than three hours. The commander of the Alecton was determined to capture this new kind of enemy; nevertheless he did not dare to lower a boat, for a single arm of this cephalopod would suffice to overturn it. The harpoons which were launched at it penetrated the flabby flesh and came out without success; several balls traversed it also unsuccessfully. Nevertheless it received one of them which appeared to wound it badly, causing it to vomit a great quantity of frothy matter and blood mixed with viscid matter which spread a strong odor of musk. It was at this instant that they succeeded in lassoing the animal, but the rope slid along the elastic body until arrested by the fins. Attempting to haul their prize aboard, they had already raised the greater part of the animal from the water when its enormous weight caused the rope to penetrate the flesh and separate the posterior portion of the body—which was drawn on board, whilst the rest disappeared in the sea.

The above is condensed from a letter addressed to M. Moquin Tandon, by M. Sabin Bertholet, consul of France, at the Canaries, who saw the fragment alluded to, and received the relation of the commandant of the vessel. One of the officers made a sketch of this animal, which, in conjunction with the description, is considered by Messrs. Crosse and Fisher sufficiently exact to warrant them in determining it to belong to a new species of Loligo, which they name *L. Bouyeri*. The figure and description show but eight arms, but the elongated form of the body, the proportional shortness of the arms and the presence of the posterior fins, show it to have been one of the decapods. Probably the tentacular arms were either deficient or were not seen.*

The fishermen mention the almost yearly occurrence at the Island of St. Paul, Indian Ocean, in the midst of schools of fishes of an enormous cephalopod, the dimensions of which exceed those of their boats, and which throws out of the water to a great distance, two long arms, covered with cups. Fearing to approach the creature, they hastily returned into the crater as soon as they saw it.†

We add, that on the 2d November, following an extremely violent tide, one of these monstrous cephalopods came ashore. It did not measure less than 22 feet from the extremity of the fins to those of the tentacular arms. M. Cazin immediately photographed the animal as it lay extended on the shore, and this photograph we have reproduced.

In a preliminary report, addressed to the Academy of Sciences, I have mentioned this great cephalopod, and identified it with the genus Architeuthis of Steenstrup. Its dimensions, its circular cups, garnished with a finely denticulated corneous ring, their disposition on the arms, seemed to indicate this affinity, but certain other characters remove it; in particular, the singularly blunt form of the arms, which appear shortly truncated instead of terminating in a point, as in all other cephalopods, as well as the inferior termination, entirely different, of the dorsal bone. It must certainly constitute, among the gigantic Ommastrephes, a new genus, which I hasten to dedicate to Commandant Mouchez.‡

Young individuals of Sepia, born in summer, had not exceeded the size of about an inch in three months, although adults are known of the size of 18 inches and more. The great differences in bulk of the same species indicate that, unlike the superior vertebrates, their growth may continue during their life. The common Poulpe, nearly 10 feet long, seen by M. Vérany, must have been very old. Admitting these premises, the question occurs, are the gigantic individuals abnormally sized specimens of common species, or does their size indicate specific distinct-

* *Jour. de Conch.*, 3d ser., ii, p. 135, 1862.

† St. Paul is a volcanic island, the crater of which is submerged.

‡ Velain. Archives Zool. Expér., vi, 83, 1877.

ness? In favor of the first hypothesis, it may be said that: I. In *nearly all* the great divisions of the cephalopods, gigantic individuals have been observed; II. Monstrous specimens of Ammonites, Nautilus, etc., are found among the fossil cephalopods, also; III. That the rarity itself of the occurrence of these large individuals would be presumptive evidence of the abnormal development of a species usually much smaller; for example, the great *L. Bouyeri* is perhaps the same species as cephalopods seen by the fishermen of the Canaries, and which do not exceed about 6 feet. On the other hand, it may be supposed: I. That the rarity of these immense animals is due to their habits as well as their size, that they frequent very great depths, and that we consequently only encounter feeble or half-dead individuals; II. That the size of some of them is so out of proportion with the ordinary size of related species, that it is wiser to consider them distinct. Messrs. Crosse and Fisher, in concluding the observations of which the above is a succinct resumé, express a guarded preference for the first hypothesis.*

Fabulous Cephalopods.—We have already alluded to Denys Montfort's "Colossal Poulpe," which, entwining its arms about the masts of a ship, nearly caused the destruction of the vessel.

Among the extraordinary mistakes or inventions with which the dawn of natural history has been encumbered, one of the most remarkable is the six-armed poulpe or *Sepia hexapodia* of Molina, in the "Hist. Nat. del Chili," 1782. It was adopted by Gmelin under the name of *Sepia hexapus*, and by Bosc, Turton and Ocken; and Denys Montfort has composed and published an imaginary figure of this strange beast in accordance with Molina's description. Férussac (*Ann. Sc. Nat. Zool.*, iv, 113, 1835) has given a history of this animal, in which he shows that the Spectre, an orthopterous insect, is the original of this "species;" which, in addition to its six arms, possessed a six-jointed body. Montfort's figure is reproduced in our frontispiece, in connection with that of the "colossal poulpe" with which his fervid imagination has enriched science.

* *Jour. de Conch.*, 3d ser., ii, 139, 1862.

Denys Montfort's monster is outdone, however, by the Norwegian Kraken described by Bishop Eric Pontoppidan as an animal, the largest in creation, whose body rises above the surface of the water like a mountain, and its arms like the masts of ships, and a whole regiment of soldiers could easily go through their manœuvres on its back. This almost marvelous account is confirmed by what happened to the Bishop of Nidros, who, discovering one of these gigantic monsters asleep in the sun, naturally mistook it for a large rock, and raised an altar on its surface, where he celebrated Mass. The good-natured Kraken permitted the worthy Bishop to finish the ceremony and regain the shore, before disappearing beneath the waves. After this account, who shall believe the malicious inventions of Victor Hugo and Denys Montfort? A celebrated Kraken of antiquity was the Hydra of Lerna, destroyed by Hercules.

Among the curious inventions of ancient and modern romancists upon the subject of the octopod or poulp, none is more bizarre than the description given of it in Victor Hugo's novel, "The Toilers of the Sea." That author invests the animal with a strange organization and stranger feelings: this "jelly seasoned with hatred has but one opening in the centre of his radial. Is this only hiatus the anus? Is it the mouth? It is both. The same opening performs both functions. It is entrance and outlet." Again, he denies to the creature a beak, yet he makes it powerful for the destruction of human life. A very caustic criticism on this work of M. Hugo, by Mr. Henri Crosse, under the title of "A well-abused Mollusk," was printed in *Journal de Conchyliologie*, 1866, and a translation of it was published in "Am. Jour. Conch.," ii, 294.

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*Cephalopods in their Relations with Other Animals.**

The number of cephalopods of small size is excessively great, but they become the prey of a multitude of enemies. On the 10th Jan., 1858, the Dutch ship Vriendentrouw sailed for two hours through dead Loligos, covering the surface of the sea as

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* A list of animals parasitic upon the Cephalopoda, is given by Keferstein (Bronn's Klassen und Ordnungen).

far as the eye of the lookout could reach. Mr. Vrolik found in the stomach of a Hyperoodon about ten thousand mandibles of Loligo.*

The cephalopoda are essentially carnivorous; their nourishment is derived from fish, the migrations of which they follow, and from Pteropod mollusca. Certain sedentary species eat crustaceans, nudibranchiate mollusks and bryozoa. After their exclusion, the young prey upon polyps, notably on those of the family Gorgonidæ, so common on the Algerine coast, and of which, some perhaps furnish the material necessary for the growth or solidification of the cuttle-bone. A little larger, they attack with avidity those elegant chaplets of pearls, the rainbow-hued eggs of Eolis and Doris.†

The chief article of food of the sperm whale is squid, of which they vomit large quantities in their death agony. Capt. Pease thinks that the whales take them by swimming with the mouth so wide open that the lower jaw stands at nearly right angles with the upper. Squid, he thinks, will grasp at the jaw as the whale passes among them, and are cut in fragments by the sudden closure of the jaws. He stoutly maintains that he has seen fragments of squid, where the whales had cut them in two, exposing the cavity of the body, which was as large over as the head of a forty-gallon cask. In one case he saw the head of a squid which he believes to have been as large as a sugar hogshead.‡

It is the opinion of almost all whalemen, that the sperm whale feeds wholly on squid. Capt. Daniel McKenzie, of New Bedford, says: "The smaller kind they eat is found near the surface, and is from 2 to 3 feet in length; the larger kind, which probably have their haunts deep in the sea, must be of immense size. I have seen very large junks floating on the surface entirely shapeless." Capt. Francis Post says: "Whales in the agony of death, frequently eject from their stomach pieces as large as the bulk of a barrel, and these in large quantities. Large pieces of

* Harting, in "Verh. K. Akad. Weten.," Amsterdam, ix, 12, 1861. Trebius Niger speaks of squids darting into the air in such numbers as to sink the ships upon which they fall, by their weight.

† Aucapitaine, *Rev. et Mag. Zool.*, 289, 1862.

‡ Shaler, *Am. Naturalist*, vii, 3, 1873.

squid are often seen floating on the sea, which whalers consider indicate good whale-ground." *

Apropos to this subject is the following "Note on the Origin of Ambergris," published by Mr. H. Crosse in *Jour. Conchyl.* (3 ser., iii, 204, 1863):

All the world is acquainted with ambergris, so frequently used as a perfume, either singly or in combination with other substances; but the singular conditions under which it is produced are by no means so well known. It is produced by the cetaceans called cachelots, and is simply a result of digestion, a sort of intestinal calculus, a coprolite. This has been confirmed by numerous observers, including both scientific men and whalers. It is formed into balls of various sizes in the digestive canal and appears with the excrement. It is probably caused by an unhealthy state of the animal, as the quantity differs in different individuals from a few to a hundred kilogrammes, according to whalers, and some animals have none. It is encountered in many parts of the world, floating on the surface of the water, than which it is much lighter. And now for the connection of this substance with our subject. The Cetaceans consume large quantities of cephalopods as food, and many of these latter when living exhale a strong odor of musk; among these may be especially mentioned *Eledone moschatus*, and the gigantic *Loligo Bouyeri*. Now amidst the ambergris are found portions of the corneous mandibles of cephalopods, which the digestion of the whale has not been able to destroy. The ambergris is then, without the least doubt, the result of the intemperate eating of cephalopods. Some of our readers who appreciate the delicate perfume of ambergris, will scarcely thank us for revealing to them in what a singular laboratory it is really prepared; but we cannot change the reality of things—and such persons can, if it seem good to them, employ for the future perfumes of less prosaic origin.

Cuttle-fish are used so extensively for bait at Newfoundland, that half of all the cod taken is fished with them. The cuttle occurs "in vast abundance, but at different times on different coasts; for example, at St. Pierre in July, on the southern coasts

* *Am. Naturalist*, vii, 90, 1873.

of Newfoundland only in August, and in Bouna Bay first in September. Its vast shoals present a curious appearance, by their strongly twisted, compact form. When they approach, hundreds of vessels are ready for their capture. At this season of the year, the sea on the coast of St. Pierre is covered with from 400 to 500 sail of English and French ships, engaged in the cuttle-fish fishery. During violent gales of wind, hundreds of tons of them are often thrown up together in beds on the flat beaches, the decay of which spreads an intolerable effluvium around. It is made no use of, except for bait; and as it maintains itself in deeper water than the capelan, instead of nets being used to take it, it is jigged—a jigger being a number of hooks radiating from a fixed centre, made for the purpose. The cod is in best condition after having fed on it. Another method of taking them is sometimes resorted to. Fires are made all along the shore during the night, when the loligo, attracted by the light, approaches too near for his safety, and is left on the strand by the recess of the tide, when the fishermen go to gather them."*

Cuttle-fish are extensively used by man as food, throughout the world; and some of the species are highly esteemed by epicures. In treating of the natural history of the ordinary European species, we shall have occasion to mention some of the methods of fishing them: it will suffice to narrate here the manner in which they are secured by some of the less civilized races of man.

In the Polynesian Islands, the natives have a curious contrivance for catching cuttle-fish. It consists of a straight piece of hard wood a foot long, round and polished, and not half an inch in diameter. Near one end of it, a number of beautiful pieces of the cowrie, or tiger shell are fastened one over another, like the scales of a fish, until it is nearly the size of a turkey's egg, and resembles the cowrie. It is suspended in a horizontal position by a strong line, and lowered by the fisherman from a small canoe till it nearly reaches the bottom. The fisherman jerks the line to cause the shell to move, as if it were alive, and the jerking motion is called "tootoofe," the name of the contrivance. The cuttle-fish, attracted by the cowries, darts out one of its arms,

* *Edinb. New Phil. Journ.*, viii, 395.

and then another, and so on, until it is quite fastened among the openings between the pieces of the cowrie, when it is drawn up into the canoe and secured.*

A species of Ommastrephes is extensively fished in Japan. Mr. Arthur Adams related that off Nisi-Bama in the Oki Islands, he saw a number of lights moving upon the surface of the water, in all directions, which he found were used to attract the cephalopods to the surface; where they were secured by a jig, an iron shank terminated by a circle of recurved hooks. Mr. Adams visited a small fishing village near the Hakodadi, where he saw hundreds of thousands of squids, cleaned and stretched on bamboo sticks, suspended on lines to dry in the sun and air.

The natives of the New Hebrides, New Caledonia, and the Feegee group of islands, capture the Nautilus, and use it as an article of food. They take them in their fish-falls, in from three to five fathoms of water; the bait they use is the Echinus. They are very fond of them. In some of the islands they make a kind of soup of them. At the Island of Ware, about 30 miles from New Caledonia, they are roasted, and taste like whelks (*Buccinum*).

The Feegeans esteem the Pearly Nautilus highly as an agreeable viand, and their mode of capturing it for the embers or the pot, is not a little interesting. When the water is smooth, so that the bottom at several fathoms of depth, near the border of the reef, may be distinctly seen, the fisherman in his little frail canoe scrutinizes the sands and the coral masses below, to discover the animal in its favorite haunts. The experienced eye of the native may probably encounter it in its usual position, clinging to some prominent ledge, with the shell turned downwards. The tackle consists, first, of a large round wicker-work basket, shaped very much like a cage rat-trap, having an opening above, with a circlet of points directed inwards, so as to permit of entry, but preclude escape; secondly, a rough piece of native rope, of sufficient length to reach the bottom; and thirdly, a small piece of branched wood, with the branches sharpened to form a sort of grapnel, to which a perforated stone is attached, answering the purpose of a sinker. The basket is now weighted with stones, well-baited with boiled cray-fish, and then dropped gently down near

* "Lovell's Edible British Mollusks," p. 167.

the victim. The trap is now either closely watched, or a mark is placed upon the spot, and the fisherman pursues his avocation upon other parts of the reef, until a certain period has elapsed, when he returns, and in all probability finds the Nautilus in his cage feeding upon the bait. The grapnel is now carefully let down, and having entered the basket through the opening on top, a dexterous movement of the hand fixes one or more of the points or hooks, and the prize is safely hoisted into the canoe.

The Pearly Nautilus is not found at the Navigator group of islands in the South Seas, and the shells form there an important article of exchange. They are brought by European vessels from New Caledonia and the Feegee Islands as articles of trade, and are bartered with the natives at the rate of four for a dollar or one shilling each. I am told it is indifferent to the natives if the shells are old or rather damaged, as they use the chambered portion for ornament, rubbing them down to suit the various purposes to which they apply them. They also make armlets and other ornaments from the shell. A vessel arrived at Sydney from New Caledonia with several tons of these shells, which were disposed of as an article of trade to the Navigator and Friendly Islands; they were sold at Sydney at about $1\frac{1}{2}d.$ each.

I have seen a very elegant fillet formed of these shells (of very small size), brought from the Samoan Islands, the brilliancy of which was that of the most highly burnished silver. They are used by the natives in war, and are highly valued; this one costing twenty dollars. The shells are fixed to a small midrib of cocoa nut leaf, which supports them on a worked band of sinnet; upon this, under the row of seventeen shells, small pieces of the same pearly shell were placed to add to the ornamental effect. The length of the band was 12 inches (not including the tying strings) and the depth 3 inches.*

In India elegant drinking cups are made of *Nautilus Pompilius*, the exterior coating being relieved by carving on the inner pearly lamina; or it is sometimes grotesquely painted. Cameo carving on the shell of the Nautilus is extensively practised in England and other countries, and shells thus prepared are highly valued as ornaments.

* Dr. George Bennett, *Proc. Zool. Soc.*, 226, 1859.

Mr. Vice-Consul Green, in a recent report, furnishes some novel and interesting particulars as to the fishing and trade in cephalopods in the Tunis waters. Octopodia and polypi are the trade names under which these cephalopods are known in the Levant and Greek markets, where they are solely imported for consumption during Lent, the orthodox Church not including them in the prohibition against the use of flesh in seasons of religious abstinence.

They prefer rocky shallows, and visit these waters, coming from the open sea, in the months of January, February and March. A considerable number of octopodia, however, remain permanently near the shores; but it has been observed that when their fry, locally called "muschi," are numerous from the month of June to August, the fishing of the coming season is sure to be abundant, whilst the reverse is the case if they appear in numbers in November and December. In a good season, the several villages on the Island of Karkenah supply about 3000 cwts., and the Jubah waters a third part of this quantity. On the shores from the village of Luesa to that of Chenies, in the Gulf of Khabs, the natives collect from 4 to 5 cwts. of cuttle-fish a day, during the season; but this supply generally serves for the consumption of the regency.

The Tunisian Government claims a third of all the polypi fished upon its coast. The selling price varies from 25 to 50 shillings per cwt. Polypi are prepared for exportation by simply salting and drying them. Malta receives the largest share of the Tunisian polypi, but they are only sent to that island for ultimate transportation to Greece and other parts of the Levant.

Portugal is one of the few countries that competes with Tunis in supplying the Greek markets with polypi. In Greece they are either sold after being pickled, at from £12.16*s.*, to £15.9*s.*, the cantar of 176 lbs., or in their original dried state, at £12 to £14, but these prices fluctuate according to the results of the season's fishing.

On the first arrival of the octopodia in the shallows, they keep in masses or shoals, but speedily separate in search of shelter among the rocks near the beach, covered by only one or two feet of water, and in the stony localities prepared for them by the fishermen, in order to frustrate (?) the depositing of their spawn. Polypi are taken in deep water by means of earthen jars strung together and lowered to the bottom of the sea, where they are allowed to remain for a certain number of hours, and in which the animals introduce themselves. Frequently from eight to ten polypi are taken from every jar at each visit of the fishermen. In less deep water earthenware drain-pipes are placed side by side, for distances frequently exceeding half a mile in length, and in these also they enter, and are taken by the fishermen. As they are attracted by white and all smooth and bright substances, the natives deck places in the creeks and hollows in the rocks, with white rocks and shells, over which the polypi spread themselves, and are caught from four to eight at a time. But the most successful manner of securing them is pursued by the inhabitants of Karkenah, who form long lanes and labyrinths in the shallows, by planting the butt-ends of palm branches at short distances from each other, and these constructions extend over spaces of two or more miles. On the ebb of the tide (the fall is here about 10 feet) the octopodia are found in the pools inside the enclosures, and are easily collected by the fishermen, who string them in bunches of fifty each, and from eight to ten of these bunches, called "risina," are secured daily during the season, by every boat's crew of four men.—SIMMONDS, *Commercial Products of the Sea.*

Dried cuttle-fish form a large article of export from Japan to China. They are called *susume*, and are brought chiefly from Esasi, Matsmai, and the west coast of Yesso, Fugaro and Yetzidzen, generally during February and October. During the quarter ending June, 1872, the imports into the three Chinese ports of Kinkiang, Shanghai and Ningpo, aggregated 4198 picals = 5222 cwt.—IBID.

For the benefit of epicures, I transcribe the following recipes from Lovell's "Edible Mollusks:"

"In Spain the cuttle-fishes (Loligo?) 'calamares' are eaten, and are either broiled on a gridiron, or stewed in red wine in an earthen jar; after which you may broil them if you like, or serve them in the wine, or stew them, adding, after they are tender, a little flour, and the yolk of an egg well beaten, and this is considered the most wholesome way of dressing them.

"*Spanish Method of Stewing Cuttles.*—Stew them over a *very slow* fire in oil or butter, and, before serving, add a little water, salt, bread-crumbs, saffron, and a *soupçon* of new honey or sugar.

"*Jersey Method of Cooking Cuttle-Fish.*—Boil them for ten minutes, then take them out, and the skin will come off like a glove, leaving the fish like so many sticks of horseradish. Then boil them for an hour longer; take them out and cut them up, and fry them with onions. Some prefer slices of bacon fried with them instead of onions, and served up with milk sauce. They are plentiful about October, and large ones are sold in the market at a penny each.

"The Italians fry cuttles in oil; they taste like skate.

"In Normandy a dish of cuttle-fish is divided in the centre by a slice of toast; on one side of the toast is a mass of cuttle-fish stewed with a white sauce, and on the other, a pile of them beautifully fried, of a clear even color, and without the slightest appearance of grease. The flour of haricot-bean, very finely ground, and which is as good as bread-crumbs, is added.

"*Weymouth Recipe for Cooking 'Scuttle.'*—Cut off the head and feelers, and take out the white bone; then boil for a short time till tender,—generally ten minutes or so will suffice. It is said to taste like lobster."

Contrast these recipes with that of the cook in Alexis' "Wicked Woman:"

"Now these three cuttle-fish I have just bought
For one small drachma; and when I have cut off
Their feelers and their fins, I then shall boil them,
And cutting up the main part of their meat
Into small dice, and rubbing in some salt
(After the guests already are set down),
I then shall put them in the frying-pan,
And serve up hot towards the end of supper."

Athenæus II, bk. 7, c. 124.

"Good-sized polypus in season
Should be boiled,—to roast them's treason,
But if early, and not big,
Roast them; boiled ain't worth a fig."

Athenæus, Deipnosophists I, bk. 1, c. 8, p. 8.

Alexis speaks thus of cooking the Teuthis:

"I took the teuthides, cut off their fins,
Adding a little fat, I then did sprinkle
Some thin shred herbs o'er all for seasoning."

Athen. Deipnosophists.

And Antiphanes in his "Female Fisher," says (referring to the ink):

> "Give me some cuttle-fish first. O Hercules,
> They've dirtied every place with ink; here take them
> And wash them clean."

Anaxilaus states, according to Pliny, that the ink of the Sepia is possessed of such remarkable potency, that if it is put into a lamp, the light will become entirely changed, and all present will look as black as Ethiopians.*

"At the nuptial feast of Iphicrates, who married the daughter of Cotys, King of Thrace, a hundred polypi and sepiæ were served up. The Greek epicures prized them most when they were in a pregnant condition, and had them cooked with high sauces; while the hardy Lacedæmonian boiled the animals entire, and was not disgusted with the black broth formed by their inky liquor diffusing itself in the water. The Octopus or Polypus was held in highest estimation. The good old story of Philoxenus may be quoted in illustration:

> "'Of all fish-eaters
> None sure excell'd the lyric bard Philoxenus.
> 'Twas a prodigious twist! At Syracuse
> Fate threw him on the fish called 'Many-feet.'
> He purchas'd it and drest it; and the whole,
> Bate me the head, form'd but a single swallow.
> A crudity ensued—the doctor came,
> And the first glance inform'd him things went wrong.
> And 'Friend,' quoth he, 'if thou hast aught to set
> In order, to it straight;—pass but seven hours,
> And thou and life must take a long farewell.'
> 'I've naught to do,' replied the bard: 'all's right
> And tight about me. . . . . .
> . . . . I were loath, howe'er,
> To troop with less than all my gear about me;—
> Good doctor, be my helper then to what
> Remains of that same blessed Many-feet.'"
>
> *Johnston's Introd., Conch.* 44.

Those of our readers who desire to pursue the *antiquities* of our subject, are respectfully referred to the veritable "Natural History" of Aldrovandi. Those who prefer modern marvels, will find a choice assortment in a paper entitled: "The Cuttle-Fish and its Allies," published in the *Popular Science Monthly*, January, 1879.

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* Lovell, *Edible Mollusks*, p. 174.

SYSTEMATIC.

CLASS CEPHALOPODA.

Head large, separate from the body, furnished with complex eyes; mouth with a pair of mandibles or beaks, resembling those of a parrot, edged with fleshy lips, and surrounded by a circle of arms.

Order 1. DIBRANCHIATA.—Breathing by a single pair of internal symmetrical branchiæ or gills. Eyes sessile. Mandibles horny. Arms, eight or ten, furnished with rows of acetabulæ or suckers. Body sometimes laterally or posteriorly finned. Shell internal, or none.

Order 2. TETRABRANCHIATA.—Breathing by two pair of branchiæ. Mandibles shelly. Arms very numerous, without suckers. Shell external, chambered; capable of containing the animal.

ORDER I. DIBRANCHIATA.

Sub-Order 1. OCTOPODA.—Arms eight, sessile; no shell.*

Sub-Order 2. DECAPODA.—Ten arms, of which eight are sessile, and two (longer) tentacular. Shell internal.

SUB-ORDER I. OCTOPODA.

(*Littoral.*)

Family 1. OCTOPODIDÆ. Mantle supported by fleshy bands. No cephalic aquiferous pores. Arms subulate, elongated, more or less united by webs; their suckers sessile.

(*Pelagic.*)

Family 2. TREMOCTOPIDÆ (PHILONEXIDÆ). Front of mantle supported by two buttons at the base of the siphuncle, fitting into grooves on the inner side of the mantle. Aquiferous pores on the back of the head. Suckers pedunculated.

Family 3. ARGONAUTIDÆ. Mantle supported by two buttons fitting into grooves at the base of the siphuncle. The two upper or dorsal arms (in the female only) expanding into velamenta or broad webs at their extremity, from which an egg-nest (shell)

* The so-called external shell of the argonaut, is the egg-nest of the female.

is secreted. Cups slightly pedicelled. A pair of aquiferous pores at the upper hinder angle of the eye.

SUB-ORDER II. DECAPODA.

A. Decapoda chondrophora. Internal shell horny.

a. Myopsidæ. Eyes covered by the skin : mostly littoral species.

Family 4. LOLIGINIDÆ. Body rather long; buccal skin sometimes armed with suckers; tentacular arms only partially retractile; fins lateral-terminal. Inner shell or gladius as long as the back.

Family 5. SEPIOLIDÆ. Body short; buccal skin without suckers; tentacular arms completely retractile; fins short, in the middle of the sides of the back. Gladius only about half as long as the body.

b. Oigopsidæ. Eyes naked : pelagic species.

Family 6. CRANCHIIDÆ. Body rounded; mantle united to the head by a cervical band, and upon either side connate with the base of the siphon; head small, with large eyes; arms short; tentacles long; siphon long, not fastened to the head, and with or without inner valve. Shell as long as the body, small, lance-like.

Family 7. CHIROTEUTHIDÆ. Body rather long; mantle supported on the body by cartilaginous ridges; sessile arms, long, partially webbed; tentacles very long; siphon short, without attachment to the head or valve. Shell or gladius small, long, lance-like.

Family 8. THYSANOTEUTHIDÆ. Body rather long or oval; mantle supported by cartilaginous ridges and grooves; arms free; siphon united to the head by two bands. Gladius dart-like.

Family 9. ONYCHOTEUTHIDÆ. Body long, cylindrical; mantle supported by cartilaginous projections; eyes with a lachrymal sinus; arms or tentacles armed with hooks; siphon with or without bands and valve. Gladius generally lancet-form, with an end-conus.

Family 10. OMMASTREPHIDÆ. Body long, cylindrical; arms short, armed with suckers only; the short tentacular arms non-retractile; siphon valved, united by bands to the head. Shell small, lancet-form, with an end-conus.

B. Decapoda calciphora. Internal shell calcareous.

Family 11. SEPIIDÆ. Eyes covered by skin; littoral. Body oval, with long lateral fins, uniting behind; mantle supported by cartilaginous tubercles fitting into sockets on the neck and siphon; arms with suckers, tentacular arms entirely retractile; siphon valved. Shell (cuttle-bone, sepion or sepiostaire) broad, flat, thickened internally by numerous plates; terminating behind in a hollow, imperfectly chambered apex or mucro, without connecting siphon.

Family 12. BELOSEPIIDÆ. (Fossil only.) Shell like *Sepia*, but the walls of the chambers of the mucro pierced by small holes, indicating the existence of a connecting siphon. Animal unknown.

Family 13. BELEMNITIDÆ. (Fossil only.) Animal, arms with hooks. Shell a pen (pro-ostracum) attached to a chambered cone (phragmocone), the partitions of which are pierced by a submarginal, ventrally-placed siphuncle; at the hinder end the phragmocone is enveloped by a rostrum.

Family 14. SPIRULIDÆ. Animal, body oblong, with minute terminal fins; mantle supported by a cervical and two ventral ridges and grooves; arms with six rows of minute cups, tentacular arms elongated; siphon valved. Shell spiral, whorls on the same plane, not in connection, chambered; chambers connected by a ventral siphon, invested by a series of cone-shaped tubes, one for each chamber. The shell is placed vertically in the end of the body, and is held in place by side flaps of the mantle.

I have adopted the above succession of families as indicating a progression from the so-called naked octopods with the internal shell represented by cartilaginous styles, through the cartilaginous-shelled cirroteuthis, to the decapods with horny pens:—then those with calcareous plates and minute initial chambers, the latter of which gradually become larger, are siphunculated, curve, become spiral and thus form a passage into the fossil tetrabranchiates and the externally shelled Nautilus. It is not impossible, that, among the ancient genera, the structure of the animals was such as to bridge over the gulf which now exists between the two orders, and it has been recently maintained by M. Munier-Chalmas, and more cautiously advanced by Dr. Paul

Fischer (see *ante*, p. 55), that many of these genera were really dibranchiate, and should be ranged with *Spirula* rather than with *Nautilus*. I shall imitate the reserve of the latter gentleman, by making no change in the classification of these fossil forms.

Family I. OCTOPODIDÆ.

Synopsis of Genera.

a. Arms with two rows of suckers.

** Body not finned.*

Octopus. Body rounded. Arms long. Suckers sessile. Third right arm of male hectocotylized.

Cistopus. Differs from Octopus in having a small aquiferous system, consisting of a bag with a small pore at its lower edge, upon the web between each arm.

Scæurgus. Body oval; wider than the head; arms short; cups with narrowed bases. Third left arm hectocotylized.

** * Body finned.*

Pinnoctopus.

b. Arms with a single row of suckers.

** Not finned.*

Eledone. Body rounded, without fins. Third right arm hectocotylized.

Bolitæna. More gelatinous than Eledone; suckers smaller, less developed.

** * Finned.*

Cirroteuthis. Body with two transverse medial fins; mantle united to the head nearly all round, by a cervical band; arms united by a web nearly to their tips.

Family II. TREMOCTOPIDÆ.

Tremoctopus. Body rounded, head large, band of the neck very small. Funnel short. Two aquiferous pores in the neck. Third right arm hectocotylized, fringed on the sides, and developed in a sack-like aperture on the side of the head.

Parasira. Body rounded; head small and short; neck-band rather broad. Funnel long. No water pores in the neck, two at the base of the siphon. Third right arm hectocotylized, not fringed, developed from a pedicelled sack. Male very different from the larger female.

Haliphron. Arm only known. With bell-shaped cups, having lily-like borders.

Family III. ARGONAUTIDÆ.

ARGONAUTA. Characters those of the family. Third right arm hectocotylized.

Family IV. LOLIGINIDÆ.

LOLIGO. Body long, with posterior rhombic fins united behind; mantle supported by a cervical ridge and by cup-like cartilages on the base of the funnel or siphon; siphon valved, attached by bands to the head; arms with two rows of suckers provided with horny, dentated rings; tentacular arms with four rows of suckers on their clubs. Fourth left arm hectocotylized at its extremity. Gladius feather-like, its shaft keeled on the ventral side.

LOLIOLUS. Body rather long, with posterior round fins united behind; siphon not attached to the head. Fourth left arm hectocotylized in its entire length. Gladius feather-like, broad. Otherwise as in *Loligo*.

SEPIOTEUTHIS. Body rather long or oval, with small lateral fins extending its entire length; siphon attached to the head by muscular bands; buccal skin, with seven projections covered with suckers; a strong wrinkle behind the eyes. Fourth left arm hectocotylized at its extremity. Otherwise like *Loligo*.

TEUTHOPSIS. (Fossil only.) Pen or gladius dilated and spatulate behind, its wings curved towards the ventral side somewhat spoon-like.

LEPTOTEUTHIS. (Fossil only.) Shaft of the pen enlarging from a point to a broad blade in front, with long lateral wings starting from the posterior pointed end.

BELEMNOSEPIA. (Fossil only.) Like *Leptoteuthis* and perhaps not separable from it. The shaft is more triangular, and the lateral wings broader, with more rounded outlines.

BELOTEUTHIS. (Fossil only.) Shaft lozenge-shaped, pointed at each end, with posterior lateral wings.

PHYLLOTEUTHIS. (Fossil only.) Gladius thin, subovate, slightly concave below, and convex above. From behind the middle it narrows towards the front, the outline of the lateral margins being convex, while the posterior end is more or less obtusely angular.*

Family V. SEPIOLIDÆ.

SEPIOLA. Body short, purse-like, mantle united to the head cervically, and ventrally supported by a ridge fitting a groove on the funnel; arms with two or eight rows of pedunculated suckers, the rings of which are not toothed, and eight rows of very small ones on the tentacular clubs.

**Belemnosepia*, *Beloteuthis*, *Leptoteuthis* and *Phylloteuthis* are *very* closely related; it is doubtful whether they should be separated.

Fins oval, dorsal. Gladius lancet-form, only half as long as the body, margins thickened. First left arm hectocotylized.

Rossia. Generally like *Sepiola*, but the mantle is supported cervically by a ridge; arms with two or four rows of sessile suckers. First left arm and middle of first right arm hectocotylized. Shell lancet-form, small.

Family VI. CRANCHIIDÆ.

Cranchia. Characters generally those of the family. Body short, rounded; fins very small, rounded, terminal; buccal membrane produced into eight lobes; arms short, with two rows of suckers; tentacular clubs finned behind, with suckers in eight rows. Siphon valved.

Loligopsis. Body long, attenuated behind, with large fins; siphon not valved; tentacles long and slender.

Family VII. CHIROTEUTHIDÆ.

Chiroteuthis. Body long, attenuated; arms long, connected by a short basal web, with two rows of small, long-pedunculated suckers; tentacles very long and narrow, covered their whole length with scattered suckers, the clubs with four rows of long-pedunculated suckers. Pen slender in the middle, slightly winged at each end.

Histioteuthis. Body short, cylindrical; head long; arms long, the three superior pairs connected by a largely developed web, the ventral pair free; tentacles long, with six rows of dentated cups on their clubs; buccal membrane six-lobed. Pen short and broad.

Family VIII. THYSANOTEUTHIDÆ.

Thysanoteuthis. Body with large triangular fins the whole length of each side; arms with lateral expansion of the skin, and two rows of pedunculated suckers, from which spring threads which are connate with the surface of the lateral expansions. Shell file-shaped.

Family IX. ONYCHOTEUTHIDÆ.

Gonatus. Body like *Loligo*; arms thick, with four rows of small suckers; tentacular clubs with many rows of small suckers, and a single large basal cup armed with a hook; siphon not connected to the head, without valve. Gladius lancet-form.

Onychoteuthis. Arms with two rows of suckers, the rings of which are not toothed; tentacles thick, their clubs with two rows of strong hooks, and at the base a rounded group of suckers, with which they are supposed to unite the two tentacles, and use them in conjunction as a *point d'appui*, where great strength is required in capturing their prey. Gladius lancet-form, with a conical commencement.

Onychia. Generally like *Onychoteuthis;* tentacles thin, clubs with two rows of hooks, two rows of suckers, and a circle of suckers at the base for supporting the tentacles together. Gladius feather-like.

Enoploteuthis. Body long, cylindrical, with triangular fins either at the end or all along both sides (sect. *Ancestrocheirus*); arms with two rows of hooks, and with sometimes (sect. *Abralia*) suckers at their ends; tentacles with hooks only; siphon connected with the head by bands; the fourth right or left arm hectocotylized. Shell feather-like or blade-shaped.

Veranya. Body cylindrical, thin, rounded behind, with fins along nearly the whole length; arms with two rows of small hooks; tentacles thin, shorter than the sessile arms, with small suckers; siphon connected by bands. Shell feather-like. Too close to *Enoploteuthis*.

Plesioteuthis. (Fossil only.) Body rather long, attenuated behind; arms with hooks. Shell small, lancet-formed, with a central and two side ridges, and an arrow-shaped point.

Celæno. (Fossil only.) Body oval; arms with hooks and suckers. Shell a rounded blade, with winged projections on either side of the pen; nucleus central.

Dosidicus. Body long; arms with large suckers on the lower half, and many small ones on the upper, thinner half; clubs of the tentacles with four or five hooks. Shell with a large, nearly solid end-cone.

Family X. OMMASTREPHIDÆ.

Ommastrephes. Body long, cylindrical; arms short, with two rows of suckers; tentacles short, not retractile, the clubs with four rows of suckers; siphon valved, fastened to the head by bands. Shell small, lancet-form, with a hollow end-conus.

Family XI. SEPIIDÆ.

Sepia. General characters those of the family; under the eyes a lid-like fold, over them lachrymal openings; six aqueous pores in the buccal membrane; arms short; tentacles long; suckers long-pedunculated; siphon with very large valve. Fourth left arm hectocotylized to its base.

Hemisepius. Differs from *Sepia* by the sessile arms having only two rows of suckers; the ventral surface of the mantle with aqueous pores situated in little nipples, and connected together by a longitudinal groove. The very rudimentary calcareous partitions of the inner side of the cuttle-bone only cover a portion of the excessively thin plate.

Family XII. BELOSEPIIDÆ.

Belosepia. (Fossil only.) General characters those of the family. Doubtfully separable from *Sepia.*

Coccoteuthis. (Fossil only.) Shell like *Belosepia*, thickened ventrally by horny, instead of chalky layers.

Family XIII. BELEMNITIDÆ.

Belemnites. (Fossil only.) Animal, arms and tentacles with two rows of horny hooks. Shell, phragmocone horny and slightly nacreous, with a minute globular initial chamber; two nacreous bands on its dorsal side, and produced beyond its rim into sword-shaped processes, represent the rostrum, which is fibrous, cylindrical, thickened behind, thin in front where it invests the phragmocone.

Belemnitella. (Fossil only.) Rostrum with a straight fissure on the ventral side of its alveolar border; its surface with distinct vascular impressions. Casts of the alveolus show that the phragmocone was chambered, had a single dorsal ridge, and a ventral process entering the fissure of the rostrum.

Xiphoteuthis. (Fossil only.) Rostrum or pro-ostracum calcareous, phragmocone very long and narrow.

Acanthoteuthis. (Fossil only.) Animal with ten nearly equal arms with two rows of horny hooks and suckers; margin of mantle free all around; fins large, medio-dorsal. Shell a phragmocone like *Belemnites*, a horny dorsal pen with obscure lateral bands and a thin fibrous rostrum with two diverging dorsal ridges.

Conoteuthis. (Fossil only.) Phragmocone slightly curved, chambered and siphunculated, with an elongated, slender pen. No protecting rostrum.

Belemnosis. (Fossil only.) Phragmocone straight or slightly curved; rostrum rather long, thickened dorsally and obtuse at the hinder end, with a ventral opening.

Beloptera. (Fossil only.) Shell straight, rostrum sometimes winged on the sides, bluntly beaked at the hinder end.

Spirulirostra. (Fossil only.) Phragmocone commencing with a spiral like *Spirula*, afterwards continuing straight; external spathose layer produced posteriorly into a long, pointed end.

Helicerus. (Fossil only.) Shell like *Belemnites*, half inch in diameter; guard thick, subcylindrical, fibrous; phragmocone slender, terminating in a fusiform spiral nucleus.

Family XIV. SPIRULIDÆ.

Spirula. (Recent.) Characters those of the family.

Family I. OCTOPIDÆ.

Genus **OCTOPUS**, Cuvier.

1. The cups of the arms sub-equal, regular.
   - *A*. The lower cups far apart, in one series.
     - *a*. Body smooth, not bearded.
     - *b*. Body smooth, bearded.
     - *c*. Back slightly granular.
     - *d*. Back granular, rough.
   - *B*. The lower cups rather crowded.
     - *a*. Body smooth, not bearded.
     - *b*. Body smooth, bearded.
     - *c*. Body minutely granular.
     - *d*. Body granular, rough.
2. The cups of the dorsal pair of arms largest.
3. The seventh to the twentieth cups of the lateral (second and third) pairs of arms much larger than the rest.
4. Doubtful and apocryphal species.

The foregoing synopsis is founded on that of Gray, (Brit. Mus. Cat. Cephalopoda Antepedia, 1849), and his arrangement of the species is generally followed by me. D'Orbigny groups the species according to the relative length of the arms—which grouping I have adopted for their more minute discrimination. The dorsal arms are considered the first pair, the laterals the second and third pairs, and the ventrals the fourth pair; they are numbered 1, 2, 3 and 4 in these pages. An attentive study of numerous specimens convinces me that there is much variation between individuals of the same species in all the discriminative characters above indicated, and that these are therefore far from constituting as perfect a scheme of classification as could be wished. A large number of species have been described without figures, and (especially by Gray) from single individuals preserved in alcohol; these may be all considered as very doubtful, and I hazard little in predicting that many of them will be found, upon careful comparison, to be mere synonyms. In different individuals of the same species I have found several different series of comparative lengths of the arms, the lower cups either far apart or crowded, the body either smooth or granulated. Owing also to the contraction, distortion and rigidity acquired by alcoholic specimens, measurements cannot be depended on. I have found no other discriminative characters that will even permit me to retain as distinct, many of the species which have acquired a certain authenticity from frequent description, illustration or quotation; and rather than run the risk of still further complicating the study by drawing conclusions from inadequate material, I prefer to adopt the imperfect and erroneous sub-divisions of Gray and d'Orbigny, and simply correct the synonymy of the species in cases where the evidence has appeared to me to be conclusive.

Prof. Steenstrup (Ann. Mag. N. Hist., 2 ser. xx, 1857) believes that the development of larger suckers upon the lateral arms is a character belonging to the males only, and that it is found even on some of the common species, like *O. vulgaris*, which Gray has placed in group 1. Thus, says Steenstrup, the male of *O. vulgaris* would belong to group 3, whilst the female would go into group 1, and the same would be the case, according to his observation, with *O. oculatus*, Orb. *O. Fontanianus*, Orb., the principal species of this 3d group, is supposed by Prof. S. to be an assemblage of males of several species. I have every reason to believe that Prof. Steenstrup is correct, but I have not enough material to decide whether the various "species" of Octopus should be reduced to one, or six or sixteen. I am compelled to retain Gray's classification, although it is worthless, and to describe fifty species almost without specific characters.

Naturalists have lost that faith in the "immutability of species," which formerly stood them in good stead of the so much more difficult, extended and careful observation of development, intimate organization and habits upon which the "species" of the future must rest; and unfortunately, the demonstration which is to supplant our already lost faith, is in most cases, not yet made.

Keferstein, in Bronn's "Klassen und Ordnungen des Thierreichs," (III, 1307-1319 and 1413-1421) gives an excellent resumé of the systematic history of the Cephalopoda, together with a copious bibliography; to which those curious in such matters are respectfully referred, as it is foreign to the purposes of this work to encumber its pages by detailing the steps by which conchologists have attained their present status of acquaintance with the organization and relations of the mollusca. For a similar reason, citations of authorities are avoided as much as possible, and particular care has been taken to compress the synonymy within reasonable dimensions and to present it collectively and separately from the descriptive portion of the work: it may be safely ignored by most readers.

1. *Cups of the arms sub-equal, regular.*

A. *The lower cups far apart, in a single series.*

a. *Body smooth, not bearded.*

Arms 4, 3, 2, 1.

O. ÆGINA, Gray.

Body oblong, elongated, marbled. Eyes very prominent, without ocular beards. Arms rather elongate. Web short. Cups rather large and far apart, equal; the five or six lower ones far apart, in a single series.

Habitat unknown.

Described from a specimen in spirits; size not given. A doubtful species.

O. ARANEA, Orb. Pl. 23, figs. 1, 2.

Body oblong, *short.* Head short, narrow; ocular beards one, posterior. Arms much elongated, smooth, slender, very unequal. Cups small, close, numerous; about 180 on the longest arms; the four lower ones in a single series. Web short.

Total length, 215 mill.; length of body, 16 mill.; relative length of arms, 1, 100 mill.; 2, 140 mill.; 3, 170 mill.; 4, 195 mill.

Isle of France.

M. d'Orbigny has seen a mutilated specimen of double the above dimensions.

O. DEFILLIPPI, Verany. Pl. 33, fig. 39.

Head rather oblong, narrow; body short; arms very long; eyes unicirrated; umbrella well developed.

Length, 524 mill.; length of sack, 40 mill.; of head, 34 mill.; length of arms, 4, 390; 3, 370 mill.; 2, 330 mill.; 1, 300 mill.

Mediterranean.

It is certainly very close to *O. aranea*; from which Verany distinguishes it by its longer head and more developed umbrella or web.

O. MOLLIS, Gould. Pl. 31, figs. 34, 35.

Body small, elongate; eyes prominent, siphuncle long, bulbous; arms graceful with thirty or forty remote cupules; umbrella thin, delicate, broad. Length, 3 inches.

Samoan Isles.

Has the characters of a young individual.

Arms 2, 1, 3, 4, *nearly equal.*

O. ALDERI, Verany. Pl. 30, fig. 31.

Body conically elongate, posteriorly acuminate; head small, rounded; no ocular cirri; umbrella very small; arms short in proportion to the body, being only one-half longer, crowded with about eighty cups. Color brilliantly spotted with red.

Length, 80 mill.; length of body, 28 mill.; length of arms, 2, 44 mill.; 1, 40 mill.; 3, 38 mill.; 4. 35 mill.

Mediterranean.

Has the facies of a Calamary, being very unlike any other species in form. Discovered in the midst of young sardines.

Arms 2, 4, 1, 3.

O. ORNATUS, Gld. Pl. 30, figs. 29, 30.

Body subglobose; head half the width of the body; eyes small, scarcely prominent; umbrella very small; arms graceful, attenuated, with numerous crowded cups; skin reticulately papillose; yellow, with lighter stripes on the back of sack, and light oval areolæ on the back of the arms; dark brown patches and mottlings distributed over the dorsal surfaces.

Length, 2·50 in.; length of arms, 2, 24 in.; 4, 21 in.; 1 and 3, 20 in.

Sandwich Islands.

Arms 1, 2, 3, 4.

O. PUSILLUS, Gld. Pl. 31, figs. 32, 33.

Body small, subglobose; head rounded; eyes large, protruding; arms robust, attenuated, with fifty or sixty large, crowded cups; umbrella large, one-third the length of the arms.

Length, 3 inches.

Mangsi Isl., China Sea.

Certainly a juvenile form. Described from specimens in alcohol. It does not seem to differ essentially from *O. mollis*, notwithstanding the order of length of the arms being reversed, and they will both probably prove to be the young of some other species.

Arms 3, 2, 4, 1.

b. Body smooth, bearded.

O. OCTOPODIA, Linn. (*vulgaris*, Lam.). Pl. 23, figs. 3, 4; pl. 24, figs. 5, 6, 7.

Body small, oval, warty, cirrose; dorsal beards placed in a rhomb; head warty; ocular beards three. Arms very large, elongate, very unequal in length; web large; cups far apart. Rarely the arms are in order 2, 3, 4, 1.

Total length, 640 mill.; length of head, 45 mill.; of body, 90 mill.; of arms, 1, 370 mill.; 2, 460 mill.; 3, 500 mill.; 4, 440 mill.—VERANY.

African, European and American coasts of the Atlantic Ocean, Mediterranean and Red Sea, Indian and Pacific Oceans.

Aristotle says of its astuteness: "To capture fish, the Polyp changes its color and takes that of the surrounding rocks." Clearque, in the second volume of his Proverbs, says: "My son, have the spirit of the Polyp, in order to sympathize with those with whom thou findest thyself." Athenæus cites these lines of Eupolis: "A man who conducts public affairs, must, in his conduct, imitate the Polyp."

The frequent loss of arms or of portions of them, endured by the Poulpe, caused the ancients to believe that when pressed by hunger, these animals devour their own members.

"He is a fool who has not more common sense than a Polyp."

The ancient and modern Greeks, as well as the Provencals, beat the flesh of the Poulpe, to render it more tender. I have seen large cross-sections of arms of Octopus exposed for sale on the quay of Santa Lucia, at Naples, along with many other kinds of shell-fish; and also in the markets of Venice. The flesh was white and firm, and resembled in appearance steaks of halibut. Fine examples of the species were living in the aquarium at Naples, during the summer of 1877; they seemed perfectly at home in its large tanks, where they could be studied to great advantage. I there confirmed many of the facts observed by Dr. Fischer at the Arcachon aquarium, and which I have elsewhere quoted (*ante*, p. 62).

Verany says, that although the Octopus usually hides itself in the crevices of rocks, which the elasticity of its body enables it to do with great facility, it sometimes frequents sandy bottoms. On these occasions, as he has several times observed, it covers itself with debris by means of its suckers, and thus hid, patiently awaits its prey. The Poulpes are fished by means of an edible morsel, attached to a line and slowly moved about their retreat. An individual having enveloped the bait in his arms, is gently drawn sufficiently near to the fisherman to enter a small hand-net. In summer, the young octopods are caught by means of a line armed with several hooks garnished with red cloth. By quickly drawing in the line, the animals may be captured. This is considered a fine pastime for the fine summer evenings at Nice. The Octopus retains his vitality for a long time out of the water, so that the fisherman is compelled to kill him at once with his knife, to prevent escape.

The meat of the Octopus has a well-marked taste, and is excellent when young. That of the Sepia and of the Calamary is preferred to it, but it is more esteemed than that of the Eledone.

The largest Octopus seen by Verany was over three yards in length, and weighed 25 kilogrammes; it was captured by a fisherman with his hands only, after a fatiguing struggle.

The action of the suckers of the Poulpe upon the skin, the serpentine motion and muscular force of its arms, and its hideous aspect, have caused to be exaggerated, says M. Verany, the misdeeds of this cephalopod, which is stupid and incapable of harm.

Mr. Jeffreys, in his admirable "British Conchology," states that the Octopus feeds principally on bivalves. The heaps of shells round their dens, which are uncovered during the recess of spring tides at Herm, are enormous; in one of these heaps, more than two thousand shells were counted, principally species of *Tapes*.

O. tuberculatus, Blainv. is, according to Jeffreys and others, a mere variety.

O. Saluthi, Verany. Pl. 25, fig. 8.

Body more rounded, covered with very irregular white verrucose spots. Head smaller, in proportion to the body; one ocular cirrus. Arms proportionally shorter, and nearly equal in length. Umbrella well developed, one-fifth the length of the arms.

Total length, 270 mill.; length of head, 30 mill.; of body, 40 mill.; of arms, 1, 185 mill.; 3, 200 mill.—VERANY.

Mediterranean.

Only a single specimen was observed by Verany. The colors appear to be more brilliant than in *O. octopodia.*

Arms 3, 4, 2, 1.

O. TROSCHELI, Targioni-Tozzetti.

Body elliptically obtuse, subpyriform, smooth; head small; eyes large; arms thick at base, dorsally carinate, attenuate towards their ends; cups, five in a single series at base of arms.

Mediterranean.

O. vulgaris, with which this has been confounded, has only three cups in single series. The distinction is very doubtful, I think. The species has not been figured.

Arms 3, 4, 2, 1.

O. GERYONEA, Gray.

Body (in spirits) marbled, smooth; head, base of arms and upper surface of web finely granulated; eyes with one fleshy tubercle, and one behind the eye; upper eyelid rugose; arms moderate, very thick at base, cups large; web broad.

Brazil.

A very doubtful species. Never figured.

c. *Back slightly granular.*

Arms 4, 3, 2, 1.

O. HARDWICKEI, Gray.

Middle of back, back of head and eyelids warty; ocular tentacles none; arms moderate, rather slender; cups rather large, the five or six lowest one-rowed, rather far apart; web rather broad, quite smooth above.

Singapore.

In alcohol (Brit. Mus.). Not figured.

Arms 1, 2, 3, 4.

O. GRŒNLANDICUS, Dewh. Pl. 32, fig. 36.

Body ovate-cordate; with one supra-ocular cirrus; arms short, acuminate, contorted, unequal; suckers small, elevated.

Greenland.

d. Back granular, rough.

Arms sub-equal.

O. Bairdii, Verrill. Pl. 32, figs. 37, 38.

Body short, thick, covered with irregular small tubercles; ocular tubercles one, large, several pointed; arms short, sub-equal, webbed one-third of their length; about 65 suckers on the dorsal and 60 on the ventral arms. Third right arm hectocotylized one-third of its length, the organ large, spoon-shaped, somewhat trilobed at the end, deeply concave within, where there are nine or ten elevated transverse folds; at the base there is a fold bent into an acute angle, the apex directed forward, leaving a deep V-shaped sinus behind it, which is in continuation with a shallow groove formed by a thickening of the web along the side of the arm and terminating midway between it and the fourth arm; at the end, the arm terminates in a small conical tip, between the two broadly rounded lobes of the spoon-shaped organ; at the base of this organ there is a slight constriction, below which the basal portion bears about 31 suckers. Length of largest specimen (in alcohol), body and head, 1·75 in., dorsal arms 2·25 in., web ·70 in.; breadth of body 1·25 in. Color when living, usually pale bluish white, thickly speckled with light orange brown and dark brown.

Males only taken, 60 to 106 fathoms, by dredge. It is somewhat related to *O. Grœnlandicus*, but the male of the latter has the third right arm much longer, with the modified portion relatively very much smaller and quite different in form, and with more numerous folds, and the basal part bears 41 to 43 suckers; the other arms also have more numerous suckers; the web is less extensive and the body is more elongated.

Casco Bay, Maine; Bay of Fundy.

Arms 4, 3, 2, 1.

O. rugosus, Bosc. Pl. 25, fig. 9.

Body oval, purse-shaped, large, with a deep ventral groove, not bearded; head short, warty; ocular beard one, elongated; arms short, thick, conical; web short. Violet brown, white beneath; sides of arms netted with brown lines.

Total length, 190 mill.; length of body, 33 mill.; of arms, 4, 155 mill.; 3, 140 mill.; 2, 134 mill.; 1, 120 mill.

Atlantic and Indian Oceans, Valparaiso, Cape Hatteras, North Carolina, Vineyard Sound, Mass. (1 spec.).

Arms 3, 2, 4, 1.

O. INCERTUS, Targioni-Tozzetti. Pl. 38, figs. 58, 59.

Body ovate, subglobose; ocular cirri two; arms short, thick, dorsally carinate, with first 1 to 3 suckers uniserial; interbrachial membrane scarcely developed.

Indian Ocean.

O. MIMUS, Gould. Pl. 33, figs. 40–42.

Body small, ovately globose, roughly reticulate; head narrow, with well-marked neck; arms robust, four times the length of the body; cupules distant, scattered, about forty pairs on the lower two-thirds of ventral arms; umbrella very large, extending up the arms. With narrow, transverse clouds of chocolate-colored dots.

Length of body, 3·5 in.; of arms, 3, 20 in.; 2, 18 in.; 4, 15 in.; 1, 14 in.

Callao, Peru.

B. The lower cups rather crowded.

a. Body smooth, not bearded.

Arms 2, 3, 4, 1.

O. EUDORA, Gray.

Ocular cirri none; arms rather short, subquadrangular, three upper pairs sub-equal; web short; cups moderate, one or two lowest one-rowed.

Described from specimens in spirits. Not figured.

Jamaica.

O. CASSIOPEA, Gray.

Body oblong, moderately long, one medial ocular beard; arms moderate, rather thick at base; cups moderate, sub-equal; web short.

Brit. Mus. (in spirits). Not figured.

Marseilles.

Arms 2, 1, 4, 3, *nearly equal.*

O. PUNCTATUS, Gabb. Pl. 34, fig. 43; pl. 19, fig. 3.

Body ovate, rounded below; head moderately large, without any well-marked neck, one-fifth the length of the body, abruptly truncated in advance of the eyes; arms subquadrate, the largest four times the length of the body; umbrella small. Very closely punctate with reddish-brown spots.

Length of body and head, 3·5 in.; length of longest arm, 10·8 in.; of shortest, 9·25 in.

The common Poulpe of the Californian coast; attains considerable dimensions. Dr. W. O. Ayres has seen one in which the arms were over 7 feet long.

Alaska to Lower California.

O. Hawaiensis, Souleyet. Pl. 34, figs. 44, 45.

Body small, globose; head large; arms strong, slightly webbed at their base, nearly four times as long as the sack. Very closely punctate with black.

Length of body, 20 mill.; of head, 10 mill.; of arms 1, 3, 4, 80 mill.; of arms 2, 100 mill.

A single specimen in alcohol. Very closely allied to, if not identical with *O. punctatus*.

Sandwich Isles.

Arms 3, 2, 1, 4.

O. Favonia, Gray.

Body oblong; eyes not bearded; arms moderate, conical; web moderate, with hard, transparent granulations above, especially between the dorsal arms; cups large, the two or three lowest one-rowed.

A single specimen in alcohol (Brit. Mus.). Not figured.

Indian Ocean.

Arms 4, 1, 3, 2.

O. Tehuelchus, Orb. Pl. 28, fig. 19.

Body round, short, very smooth; arms elongated, compressed, nearly equal; cups about 100 on the longest arms; web thin; siphuncle elongate, narrow. When alive blackish brown, whitish beneath.

Length of body, 22 mill.; of arms 4, 135 mill.; 1, 130 mill.; 3, 130 mill.; 2, 117 mill.

Resembles *O. Hawaiensis* very closely.

Patagonia.

Arms nearly equal.

O. BREVIPES, Orb. Pl. 25, fig. 10.

Body oblong, large; head short, broad; eyes prominent, without lids; arms short, conical, about one-third the length of the animal, upper pair rather longest. Bluish with red spots.

Length of body, 7 mill.; of superior arms, 6 mill.; total length, 17 mill.

D'Orbigny distinguishes this from all other species by the shortness of its arms; it is doubtless young.

23° *N. lat.*, 35° *W. long.*, *Atlantic Ocean.*

O. FURVUS, Gould. Pl. 35, figs. 48, 49.

Body pyriform; head elongate, dilated below; eyes large, with three cirri; arms very long, graceful, sub-equal; suckers large, approximate, 96 pairs on upper arms; web small. Ochraceous, mottled. Length of body, 6 in.; of arms about 40 in.

Obtained in the market and from fishermen.

Rio Janeiro.

Arms 2, 1, 3, 4.

O. TETRACIRRUS, Chiaje. Pl. 27, fig. 17.

Body oval, bursiform, flaccid, with sometimes a tubercle at its extremity; head rather large, with prominent eyes, and two ocular cirri; arms three times the length of the body, conical-subulate, laterally compressed, with about 130 small cups on the longest; web very elastic and much developed, embracing a quarter of the arms; siphon short, cylindrical and rather large proportionally; skin very elastic and a little transparent.

Total length, 200 mill.; length of arms, 2, 130 mill.; 1, 128 mill.; 3, 102 mill.; 4, 96 mill.

Distinguished by its very elastic skin and flaccid consistence, its brilliant coloring and its well-developed web.

Sold in the Genoese markets.

Mediterranean.

b. Body smooth, bearded.

Arms 4, 3, 2, 1.

O. HORRIDUS, Orb. Pl. 25, fig. 11.

Body short, round, with numerous, regularly placed, diverging beards; head short, with diverging beards round the eyes;

arms short, thick, five or six bearded externally, conico-subulate, nearly equal; cups rather large, one or two lowest one-rowed; web moderate, extending up the outer edge of the arms. Bluish, with large; regular, round, white spots.

Red Sea; South Africa.

O. FILOSUS, Howell. Pl. 36. fig. 50.

Body oval, purse-shaped, with dorsal beards; head narrow, short, with a depression between the prominent eyes; ocular beards six; arms robust for about half their length, then abruptly becoming filamentous, where the cups are in a single row to their tips; web moderate. Reddish, inner surface of arms cream color.

Remarkable for the long and thread-like terminations of the arms.

Very active; caught with difficulty.

St. Croix, W. I.

Arms 4, 2, 3, 1.

O. ACULEATUS, Orb. Pl. 26. figs. 12-14.

Body short, rounded, small, covered near the head with numerous beards; head long-bearded, beards crowded, forming a circle round the eyes; arms thick, bearded externally; cups very large and numerous; web short. Whitish.

Manilla; Borapora.

c. Body minutely granular.

Arms 2, 3, 4, 1.

O. SAPHENIA, Gray.

Ocular beards none; arms moderate, three upper pairs sub-equal; web short, granular above. Described from specimens in alcohol (Brit. Mus.); not figured.

Pacific Ocean; E. Coast of South America.

O. BERENICE, Gray.

Body oblong, minutely granular and with regularly disposed roundish groups of small granules; eyes fringed with four or five granulated tubercles on the dorsal edges; arms moderate; cups very large; web moderate, rather wider below.

From specimen in spirits (Brit. Mus.), presented in 1805; not figured.

Habitat unknown.

Arms 2, 4, 3, 1.

O. SUPERCILIOSUS, Quoy and Gaimard. Pl. 27, fig. 18.

Body oval, acuminated behind, slightly granular, long-bearded; head very distinct, swollen, smooth in the middle, tuberculate over the eyes; arms elongated, angular, conical, nearly equal; cups far apart, large; beak without lateral wings. White when alive.

Total length, 100 mill.; length of body, 16 mill.; length of arms 2, 77 mill.; 4, 76 mill.; 3, 70 mill.; 1, 66 mill.

Bass' Straits, Australia.

Arms 4, 3, 2, 1.

O. LUNULATUS, Quoy and Gaimard. Pl. 26, figs. 15, 16.

Body short, with scattered tubercles and about twenty prominent circles with concave centres; head short, thick, tubercular; arms short, conical, nearly equal, with circles on and between them; cups about fifty; web very short. White; the circles blue, paler in the centre.

Length of body, 8 mill.; length of arms 4, 21 mill.; 3, 20 mill.; 2, 18 mill.; 1, 17 mill.

New Zealand.

Well distinguished from all other species by its remarkable coloration.

d. Body granular, rough.

Arms 2, 3, 4, 1 *or* 3, 2, 4, 1.

O. TETRICUS, Gould. Pl. 35, figs. 46, 47.

Body large, oblong-ovoid, bilobed ventrally; head subquadrate, eyes minute; arms very robust, subquadrate, rather short, with eighty to ninety pairs of cupules; umbrella large, the membrane passing up the arms two-thirds of their length. Surface rough with warty granulations, especially large and prominent on back of head and upper half of umbrella; three cirri over the eyes and apparently one below, and three along back of head.

Length of body, 2·5 in.; length of arms 2, 16 in.; 3, 16 in.; 4, 13 in.; 1, 12 in.

Near Sydney, New South Wales.

O. TUBERCULATUS, Blainv. Pl. 29, figs. 22–27.

Body short, round, back with four conical, acute, diverging beards; head short, ocular beards two, the hinder elongated; arms short, cups very large, the first three in one line; web rather wide, extending up the arms. Violet brown, beneath white.

Total length, 400 mill.; length of body, 80 mill.; length of arms 2, 300 mill.; 3, 270 mill.; 4, 240 mill.; 1, 230 mill.

This species may be considered rather doubtful. Dr. Fischer, Mr. Jeffreys and Verany regard it (notwithstanding its tuberculate surface, etc.) as a variety of *O. vulgaris*, whilst d'Orbigny, Gray, Weinkauff and Targioni think it distinct.

Mediterranean Sea; Atlantic Coasts of Europe, Africa; West Indies; Pacific Ocean.

Arms 4, 3, 2, 1.

O. POLYZENIA, Gray.

Body oblong, rounded, short, with a few scattered warts or beards; arms slender; web short; cups large.

Port Essington, Australia.

A specimen in Brit. Mus. Not figured.

Length of arms not stated.

O. BOSCII, Lesueur.

Body roundish, back with a few regularly placed larger tubercles; eyes with three conical beards; arms elongate, without beards, the upper pair with a very wide dorsal membrane; web moderate.

A very doubtful species. It may = *O. polyzenia*, but probably neither of them are good species.

Australia.

2. *Cups of the dorsal pair of arms largest.*

Arms 1, 2, 3, 4.

O. CUVIERI, Orb. Pl. 38, fig. 56; pl. 37, fig. 55.

Body oblong, enlarged below, warty above, and with a medial posterior beard; aperture of moderate size; ocular beards indistinct. Arms very long, slender, unequal, the 1st and 2d much longest. Web broad. Cups elevated, some on the two upper pairs of arms larger.

Total length, 600 mill.; length of body, 40 mill.; length of arms 1, 530 mill.; 2, 460 mill.; 3, 420 mill.; 4, 370 mill.

Canaries; Mediterranean; Red Sea; Indian and Pacific Oceans.

This species well illustrates the uncertainty of distinctive characters in the Cephalopoda, for Verany thus describes its superficial appearance: "Body oval, with the extremity a little acuminated during life, rounded after death; tuberculate or verrucose when irritated, granulose when quiet, smooth when languid." With these changes of surface the color also changes. It appears in the markets of Genoa when the dredge fishery begins, being only taken by this means. It does not appear to be social, as individuals are only captured singly. Its meat is less highly estimated than that of the *O. vulgaris*. The largest specimens attain about 3·5 feet in length. At Nice it is called "Poupressa," at Genoa "Scorrià," in Sardinia "Purpu arrabicu," and in Sicily "Fraiddu russu."

Arms 1, 3, 4, 2.

O. MEDORIA, Gray.

Body, head and arms minutely granular, with scattered rather larger rounded tubercules; body oblong, rather acute behind; eyes large, ocular tentacles none; arms elongate, slender; cups rather small, regular, equal, of the dorsal pair rather largest; web moderate, scarcely wider beneath, smooth above.

A single specimen (in alcohol) in Brit. Mus. Very likely = *O. Cuvieri*.

Habitat unknown.

3. *The seventh to the twentieth cups of the lateral arms much longer than the rest.*

Arms sub-equal.

O. FONTANIANUS, Orb. Pl. 37, fig. 54.

Body large, slightly warty; head narrow, nearly smooth, with one posterior ocular beard; arms moderate, angular, sub-equal; cups close together, the second to tenth of 2d and 3d pairs of arms much largest. Web very broad. Violet colored.

Total length, 230 mill.; length of body, 37 mill.; of arms, 165 mill.

A single specimen in Coll. A. N. S., Phila., from Sandwich Islands, I incline to include with this species, although its surface is quite granular, with many beards.

Chili, Peru.

O. MEGALOCYATHUS, Couthouy. Pl. 36, fig. 51–53.

Body ovate, smooth, with a narrow lateral border somewhat like a natatory membrane; head narrow; eyes prominent; arms long, with some of the suckers very large; umbrella very large, its membrane extending to the tips of the arms. Color of back dark chocolate, with streaks of ashy white; ventrally much paler.

Total length, 43 in.; length of body, 5·2 in.; of arms, 34 in.

This species is described as smooth, and no mention is made of ocular spots; otherwise it is closely allied by its lateral membrane and general characters to *O. membranaceus*.

Orange Harbor.

Arms 2, 3, 4, 1.

O. MEMBRANACEUS, Quoy. Pl. 28, figs. 20, 21; pl. 29, fig. 28; pl. 38, fig. 57.

Body obtuse, acutely granular, with a lateral membrane; head large, granular above and below, ocular beards three, elongate; arms moderate, quadrangular; cups large, the fourth or fifth cups of the lateral arms much larger than the rest; web moderate, granular. An oval blackish eye-like spot between the bases of the 2d and 3d pairs of arms.

I have figured a portion of membrane with attached eggs (Pl. 20, fig. 6), obtained by M. d'Orbigny from one of the animals collected by Quoy; also an enlarged view of the same, showing the embryos (ibid, fig. 7). I do not think it belongs to this species or genus, however (see *ante*, p. 44).

The museum of the Academy of Natural Sciences, of Philadelphia, possesses three fine specimens of this species, fully double the size of those figured by d'Orbigny and Quoy.

New Guinea, Japan, China.

Arms 2, 4, 3, 1.

O. CYANEA, Gray.

Body ovate, above rather granular, beneath smooth; ocular tubercle rugose, superior; arms rather elongate, conical; cups large, the 10th to 20th of the lateral pairs larger, equal sized, the lowest, especially of the ventral arms, one-rowed; web broad, minutely granular above, especially between the upper arms.

Described from alcoholic specimens in Brit. Mus.

Australia.

Arms 3, 2, 4, 1.

O. Cephea, Gray.

Body smooth, oblong, rather elongate; ocular beard small, surrounded by other smaller beards; arms thick, moderately long; web broad, broader in front, upper surface quite smooth; cups very large, the 10th to 20th of lateral arms larger, equal, the four or five lowest of all the arms, one-rowed. Very like *O. vulgaris*, but differs in the lateral cups.

Specimens in alcohol, Brit. Mus.

Habitat unknown.

4. *Doubtful and apocryphal species.*

O. cærulescens, Péron. Body short; arms much longer than body; cups ending in a point, but not clawed. Blue, varied with very small close purple dots; cups whitish.—Blainville.

The form of the cups, if correct, would indicate a different family.—Gray.

Australia.

O. longipes, Leach. Body elongated, oval, glabrous, gray spotted with black. Arms very long, slender. Cups large, rather prominent. Prob. = *O. Cuvieri* or *O. aranea.*—Gray.

Habitat unknown.

O. brevitentaculatus, Blainv. Body short, globular, smooth; arms thick, cirrous, conical, short; proportion of length, 2, 3, 4, 1; the longest only three times as long as the head; cups large.

Probably *O. octopodia* (*vulgaris*) contracted.

Habitat unknown.

O. venustus, Rang. Pl. 29, fig. 28 *a*.

Body oval, purse-formed, smooth; aperture large; head short, rather broad; eyes prominent; arms rather short, nearly equal; cups small.—Rang.

Indeterminable. A young specimen.

Algiers (Aucapitaine); *Isle of Goree.*

O. GRANOSUS, Blainv. Body small, globular, rather transverse, finely granulated above and below; arms eight times as long as the body; proportionate length, 4, 3, 2, 1; web slight.

Mediterranean.

This description has not been identified by European malacologists with any Mediterranean form.

O. PILOSUS, Risso. Body round, gray, ashy-brown, provided above with reddish hairs disposed in bundles; arms very short, thick; cups large; eyes very large and very prominent.

Mediterranean.

O. FRAYEDUS, Raf. Arms equal, six times as long as the body, without any cups at the end.

Mediterranean.

O. DIDYNAMUS, Raf. Arms unequal, the upper pair longest, nearly five times as long as the body.

Mediterranean.

O. TETRADYNAMUS, Raf. Arms unequal, alternately longest, about five times as long as the body.

Mediterranean.

O. HETEROPUS, Raf. Arms unequal, very short, scarcely as long as the body, the upper pair longest. Back reddish.

Mediterranean.

O. PUSTULOSUS, Péron. Body rugose. Arms shorter and thicker than those of *O. variolatus* and with larger and fewer cups. Brownish green.

Australia.

O. FANG-SIAO, Orb. Described from an article in the "Encyc. Japon." No specific characters are given. Its eggs are like grains of rice, and it is fished by using a species of Murex for bait. Considered good eating by the Japanese.

Japan.

O. MOSCHATUS, Raf. Arms of equal size, four times the length of the body. Color whitish.

Mediterranean.

O. CAPENSIS, Souleyet. Pl. 38, fig. 60.

Body ovate, smooth; arms very short, equal, semipalmate. Whitish, semitransparent with brown spots.

Total length, 12 mill.

Undoubtedly a very young animal.

Cape of Good Hope.

Genus **CISTOPUS**, Gray.

C. Indicus, Rüppell. Pl. 39, figs. 61, 62.

Body smooth, pouch-shaped, not bearded; arms rather elongated, unequal, order of length 1, 2, 3, 4; cups large, two or three near the base of the dorsal pair of arms largest; web very broad; bearing oval aquiferous pouches, one between each pair of arms, with their openings at the base.

Total length, 340 mill.; length of body, 35 mill.; of arms 1, 290 mill.; 2, 250 mill.; 3, 195 mill.; 4, 190 mill.

Celebes; India.

Genus **SCÆURGUS**, Troschel.

As the principal character on which this genus is founded, is the hectocotylized arm of the male, it is sometimes impossible to ascertain whether specimens belong to this genus or to *Octopus*. It is very probable that some of the species described under *Octopus* should be placed here.

S. titanotus, Troschel.

Body oval, rounded behind, with a slight inclination to a point, its length a fourth more than its breadth, skin thickly granulated, with calcareous particles imbedded in it; head a little smaller but not plainly separated from the body; eyes small with a conical tentacle; arms about double the length of body and head, the three superior pairs granulated externally, the inferior pair smooth; length similar (3, 2, 1, 4); suckers 140 to 164 on each arm. Brownish-red with violet spots.

Mediterranean.

The proportionate length of the arms, and color are different from *S. Coccoi;* the suckers are also larger. The species has not been figured in its entirety. I doubt its distinctness from *S. Coccoi.*

S. Coccoi, Verany. Pl. 39, fig. 63.

Body oval, slightly granulate and bearded; yellowish, sides and membrane margined with blue; arms sub-equal, dorsally bearded; a prominent ocular beard. Proportionate length of arms 2, 3, 1, 4.

Genoa.

Genus **PINNOCTOPUS**, Orb.

P. CORDIFORMIS, Quoy. Pl. 40. fig. 64.

Body orbicular, tuberculate, winged; arms long, nearly equal, lateral ones shortest; eyes rather prominent. Red brown; arms with pale blue lunules.

Total length, 39 in.; length of body, 8 in.

New Zealand.

Genus **ELEDONE**, Leach.

a. Ocular cirri one; arms sub-equal.

E. MOSCHATUS, Lam. Pl. 40, figs. 65, 66.

Body oblong, smooth, minutely granulate or cirrose at the will of the animal; arms elongate, graceful. Color grayish or yellowish, with spots of blackish punctations, the border of the umbrella bluish.

Total length, 440 mill.; length of arms, 300 mill.; of body, 9 mill.

Having the odor of musk—even after death.

This species inhabits from 10 to 100 metres in depth, rocky as well as sandy shores; it appears in the markets of Genoa in quantities from September to May. It is able to throw itself out of the water to a distance of 8 or 10 feet, and can also eject water from its funnel for over a foot. Verany has seen it repeat this jet eight times, taking six to eight respirations between each jet.

Notwithstanding its musky odor, this species is preferred for food to *E. Aldrovandi;* some skin it, and others use seasoning to diminish this odor. Its flesh is more tender than that of the Octopus, but it has less taste and is not so well liked. It is used boiled, as a salad, fried or as a ragoût. It is called Moscariello at Naples, Purpu Muscareddu in Sicily, Moscardino at Leghorn and Genoa, Nouscarin at Nice, and Purpu Muscao in Sardinia.

Mediterranean.

The women of the tribe of M'talassa (Algiers) anoint their hair with the black liquid which they collect from this mollusk, but whether they use it as a dye or for the sake of its musk-like perfume, I do not know. The perfume appears to me to be capable of industrial use.—AUCAPITAINE, *Rev. et Mag. Zool.*, 366, 1862.

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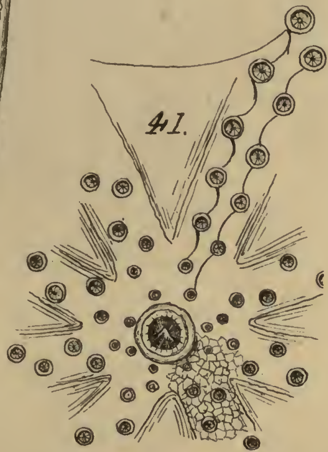

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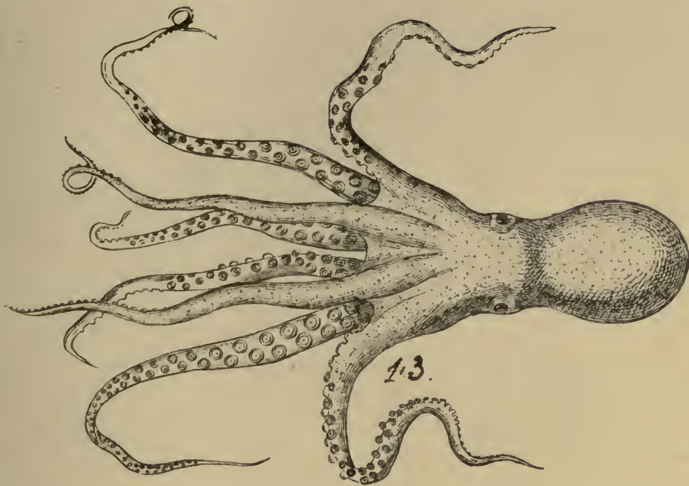

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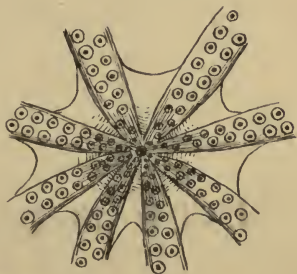

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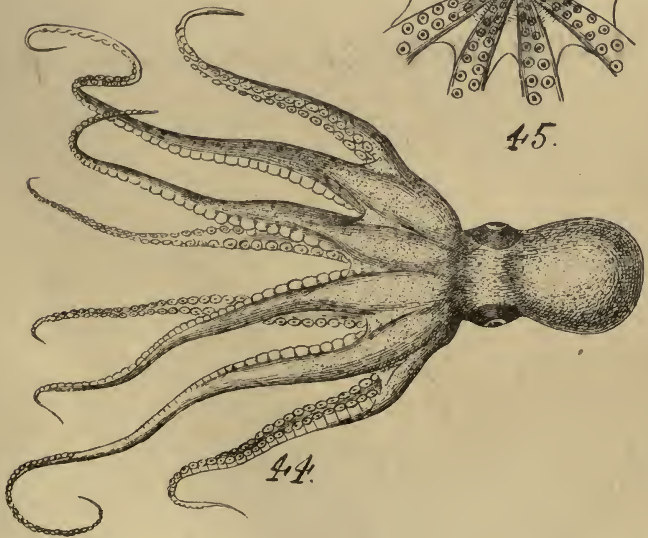

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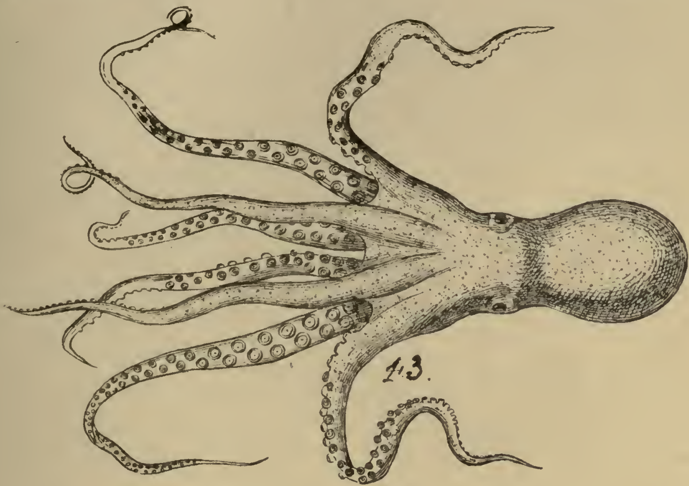

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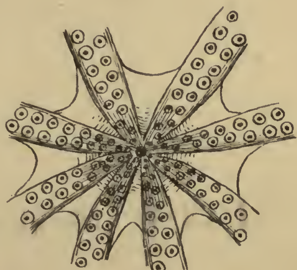

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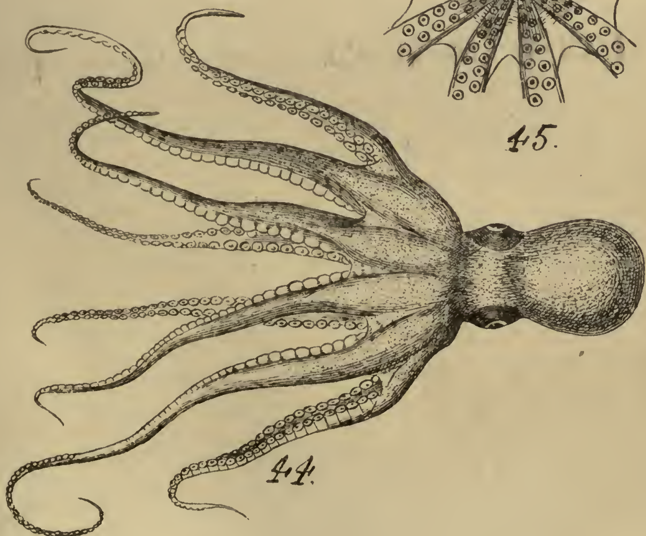

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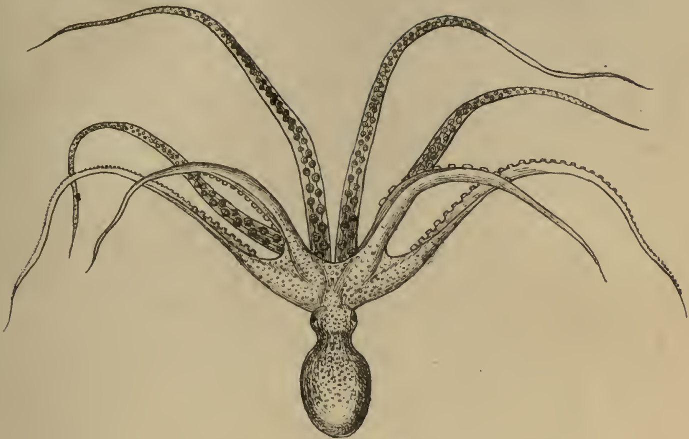

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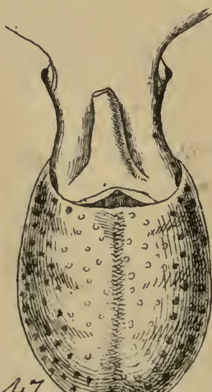

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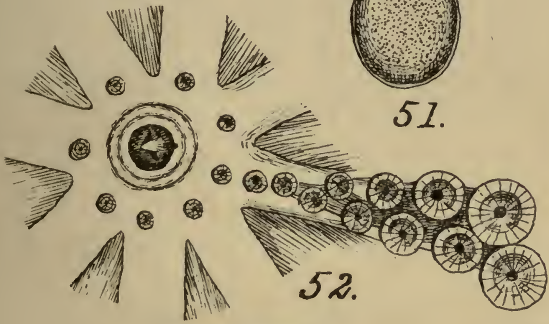

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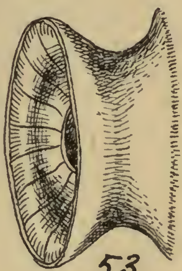

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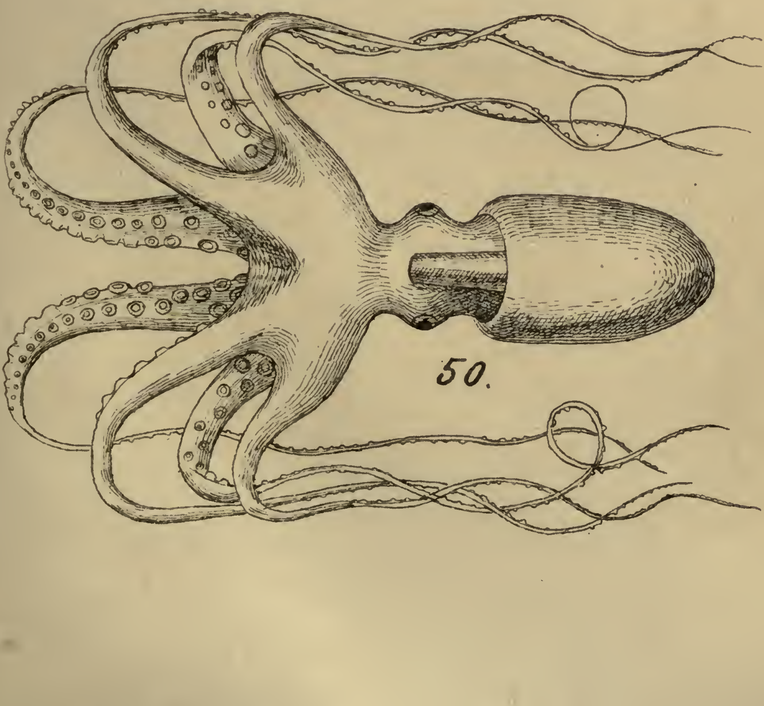

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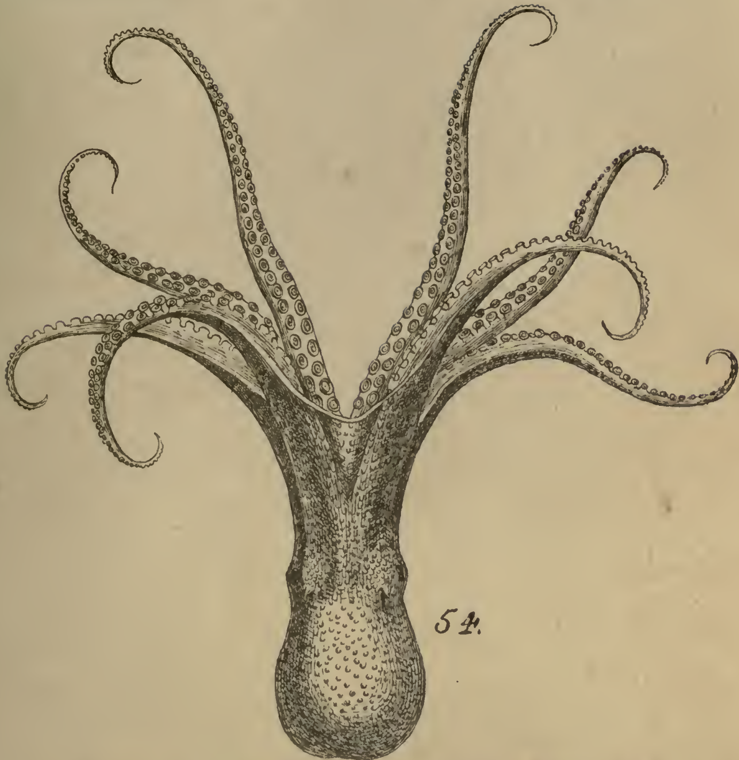

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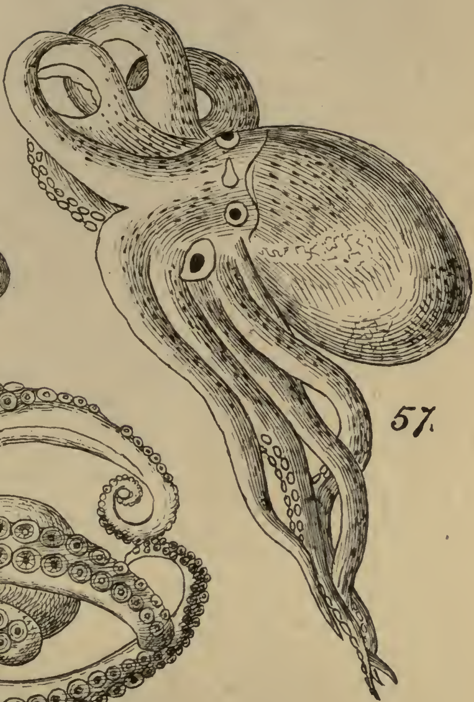

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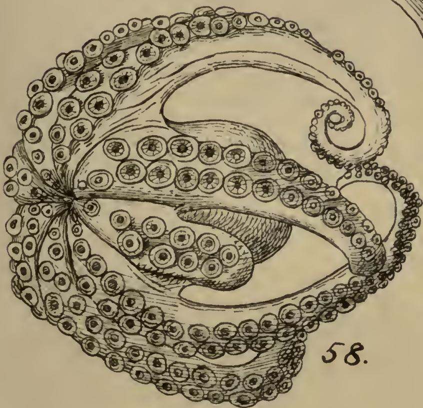

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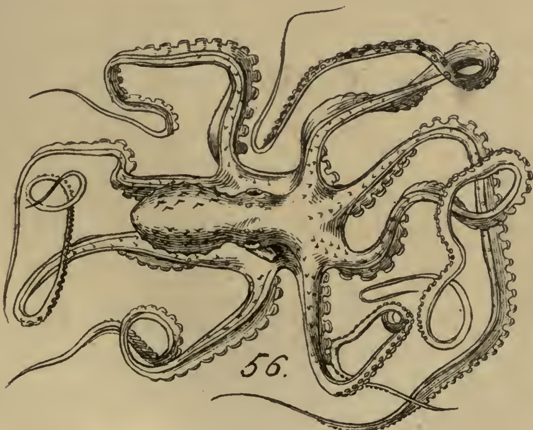

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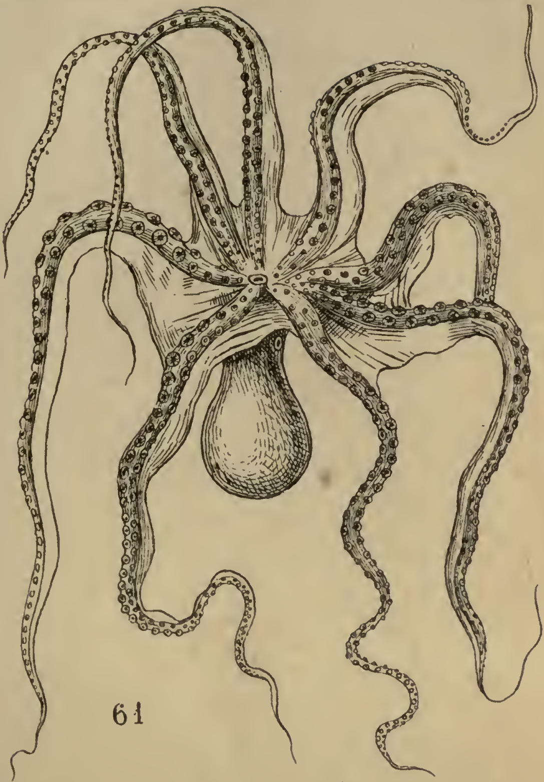

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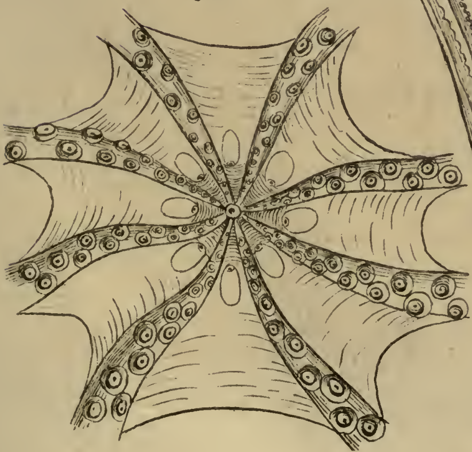

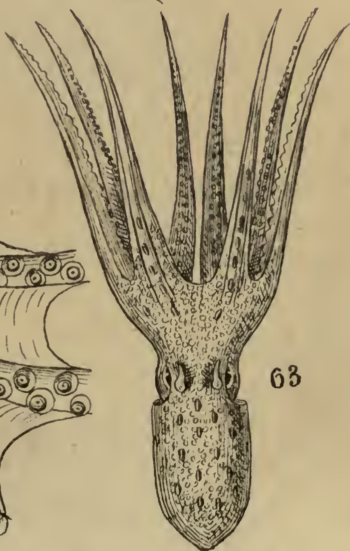

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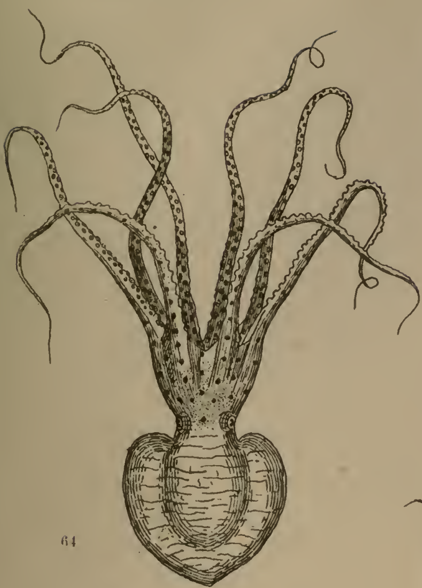

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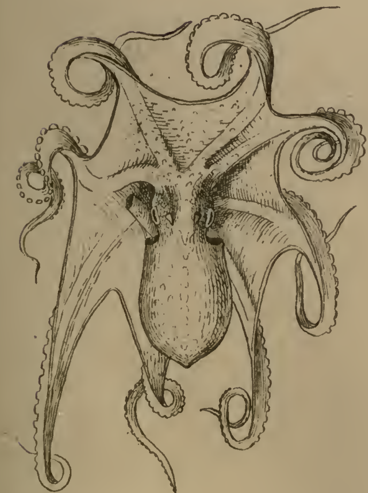

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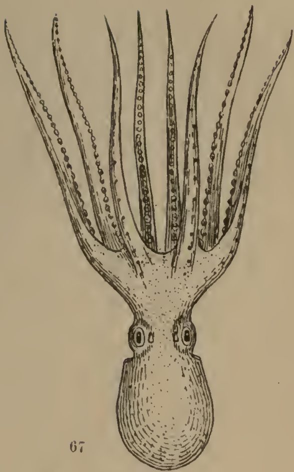

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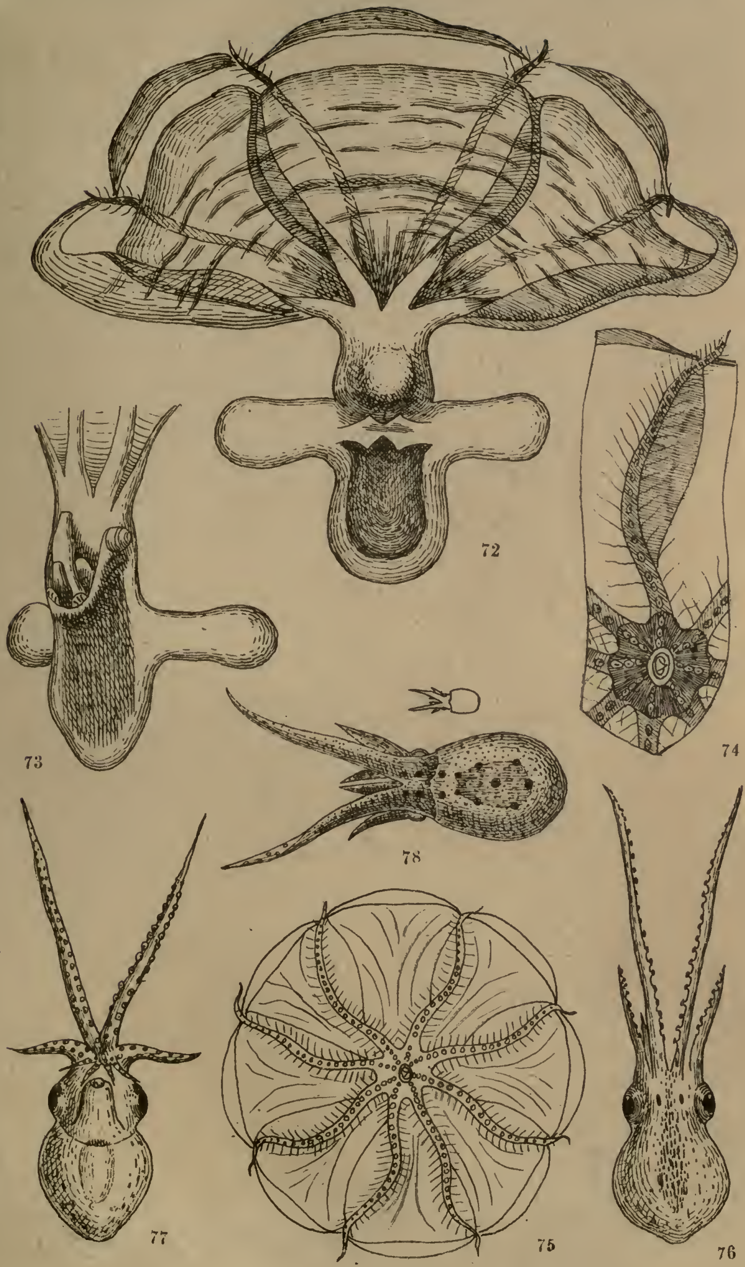
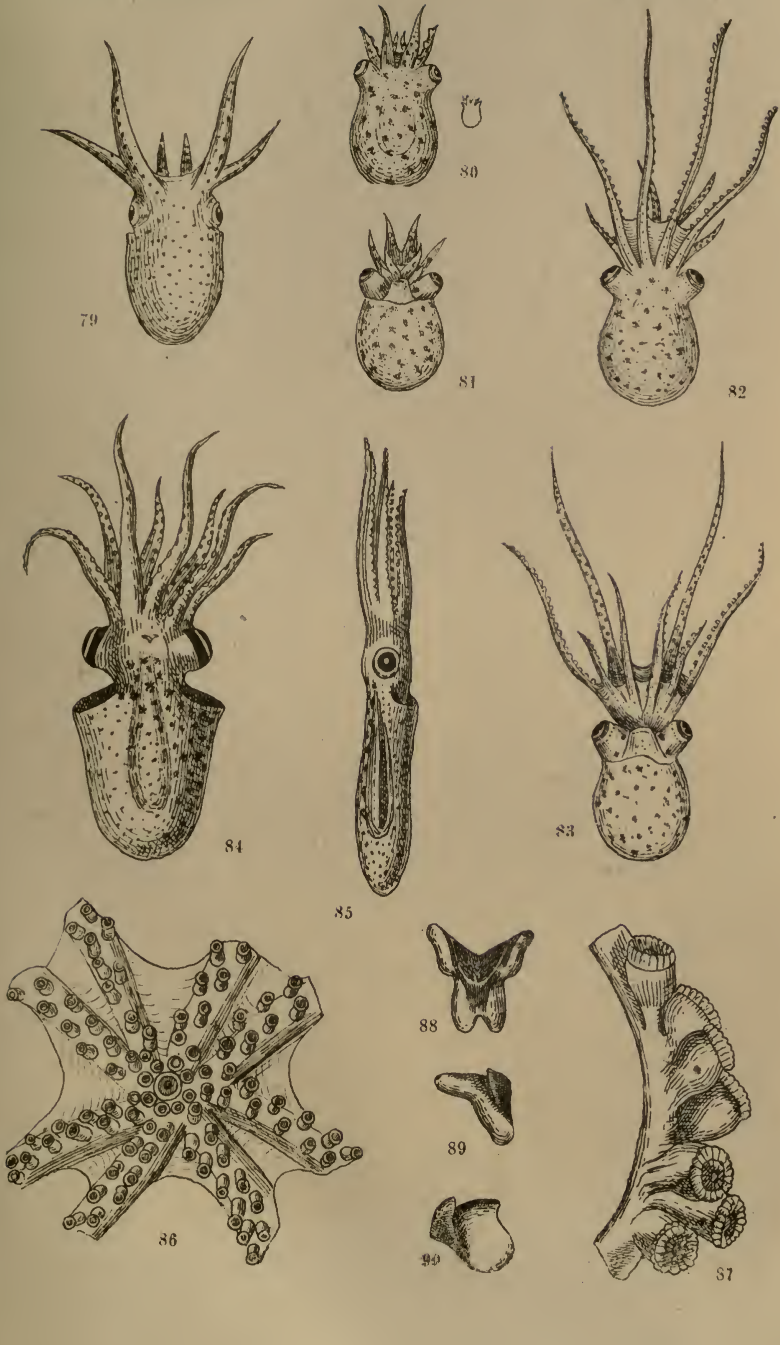
CEPHALOPODA. PLATE 42

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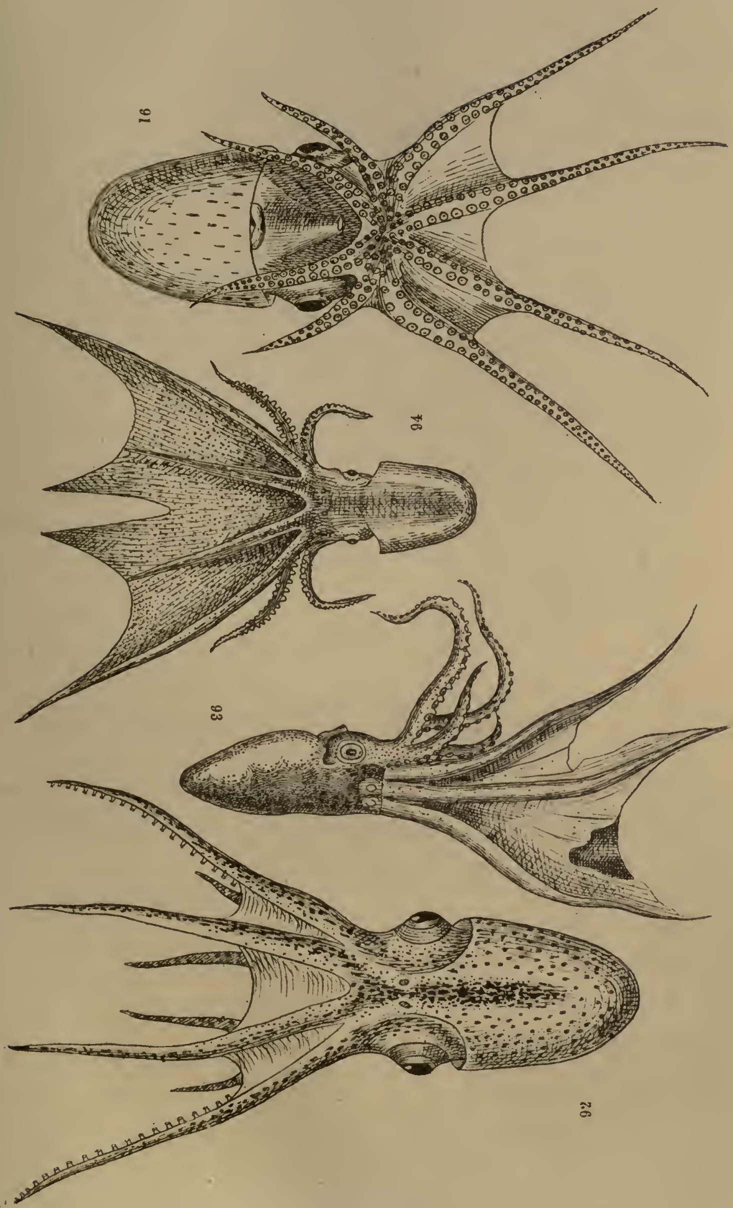
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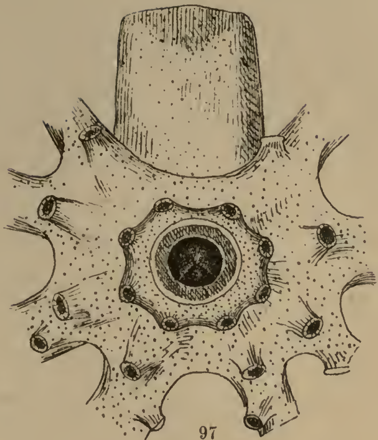
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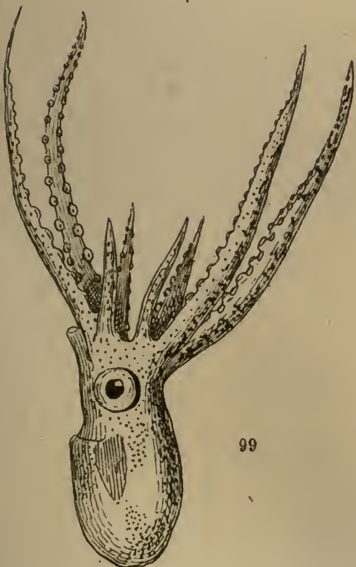
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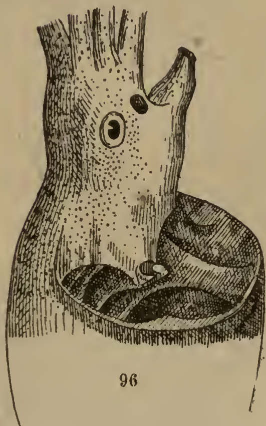
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CEPHALOPODA. PLATE 46.

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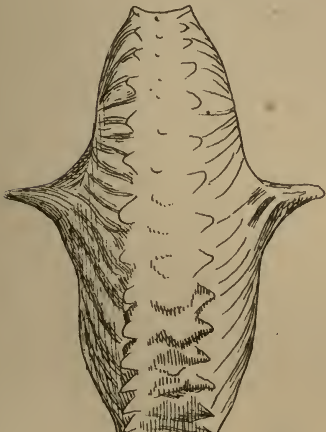

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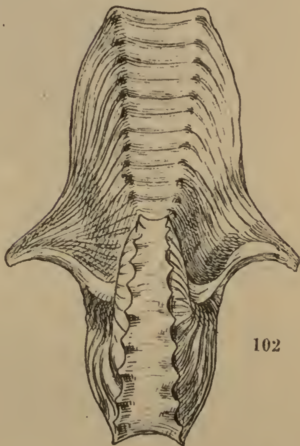

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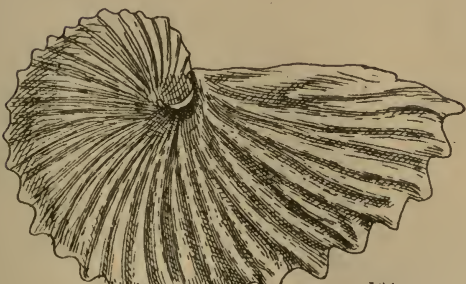

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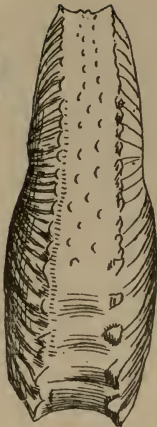

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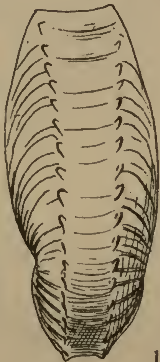

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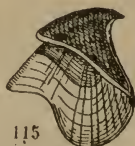

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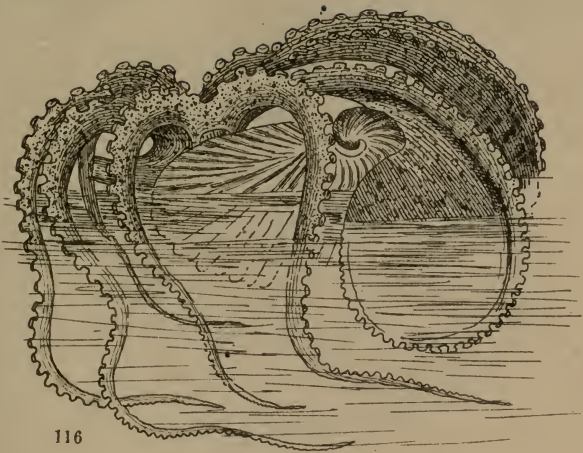

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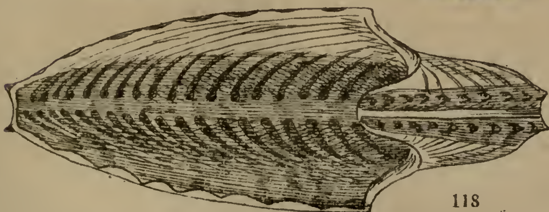

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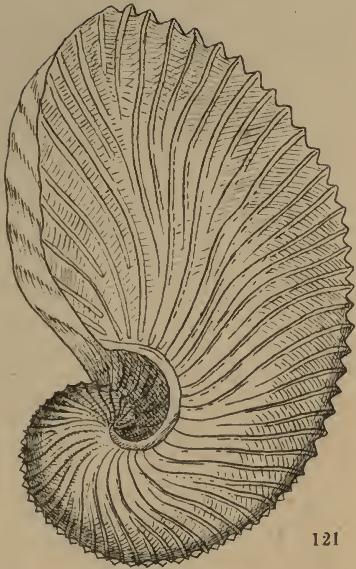

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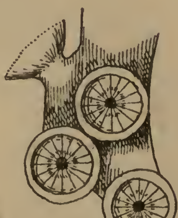

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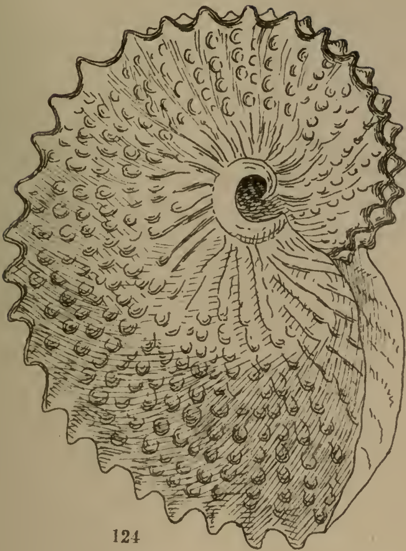

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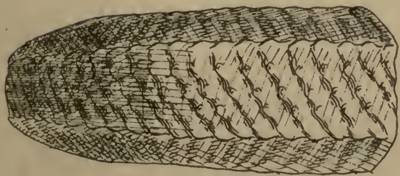

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E. Aldrovandi, Chiaje. Pl. 41, fig. 69.

Body oblong, smooth or minutely granulated; arms elongate, graceful. *Reddish*, nebulous, *web not bordered with blue. No musky odor.*

Total length, 400 mill.; length of arms, 290 mill.; of body, 90 mill.; of head, 40 mill.

Generally confounded with *E. moschatus;* the differences of the living animals disappearing in alcoholic specimens.

Var. Genei, Verany. Pl. 40, fig. 67. Differs but little from the typical form; the backs of the arms have a single series of red spots.

Mediterranean.

b. Ocular beards none; arms unequal.

E. octopodia, Pennant. Pl. 41, figs. 70, 71.

Body rounded, smooth or minutely granulated; head scarcely distinct from the body; arms 1, 3, 2, 4 in relative length; cups close together. Pale with small brown spots.

Total length, 150 mill.; of body, 25 mill.; length of arms 1, 110 mill.; 3, 97 mill., 2, 95 mill.; 4, 95 mill.

Ström says it is called *Suar* by the Bergen folk, and that it sticks so fast to fishes as to be often taken with them. Johnston* says: "When at rest, this Octopod lies prone on the belly, the arms spread out in front, with their extremities exposed in spirals on the sides. It has in this position a considerable likeness to a toad; and, often raising the back and head, its aspect is really repulsive and threatening. It moves quickly, and always retrograde, playing its arms in a regulated, graceful manner, which no one can contemplate without wonder in a body so grotesque and apparently so inapt for locomotion."

Northern and Atlantic coasts of Europe.

Genus **BOLITÆNA**, Steenstrup.

In the description of this genus no type is cited. In Woodward and Keferstein a single living species is mentioned, but without name.

* Proc. Berw. N. H. Club, I, 198.

Genus **CIRROTEUTHIS**, Eschricht.

C. MULLERI, Eschr. Pl. 42, figs. 72–75.

Body smooth, purse-shaped, with medial and dorsal lateral expansions or fins, head narrower, with very small eyes; arms equal, united almost to their ends by a thin web, which is so ample as to form a sort of pouch between each; about thirty small suckers in a single row on each arm, with a pair of filiform cirri between each sucker. Color violet.

Length of animal, 250 mill.; of body, 80 mill.; of arms, 110 mill.

Greenland.

Family II. TREMOCTOPIDÆ.

Genus **TREMOCTOPUS**, Chiaje.

T. ATLANTICUS, Orb. Pl. 42, figs. 76, 77.

Body smooth, roundish, large; head moderate, smooth; eyes large, without lids; aqueous pores two; arms slender, unequal, in order 1, 2, 4, 3; not webbed except at base. White spotted with red.

Habits nocturnal. Pelagic.

Differs from *T. Quoyanus* by the want of membranes between the superior arms, and of the lower aquiferous pores. It is certainly not adult, and may be the young of *T. Quoyanus* as d'Orbigny suggests.

Total length, 15 mill.; of body, 4 mill.; length of arms 1, 10 mill.; 2, 5 mill.; 4, 3 mill.; 3, 1 mill.

Tropical Atlantic Ocean.

T. MICROSTOMUS, Regn. Pl. 42, fig. 78.

Body rounded, large, smooth, reddish; head broad; eyes very prominent; arms smooth, short, not webbed; order of length 1, 2, 4, 3.

Total length, 22 mill.

Trocchel* considers *O. Kœllikeri*, Verany (Pl. 43, fig. 79), the female of this species. D'Orbigny thinks it the same as *T. Atlanticus* above.

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* Archiv. I, 44, 1857.

Verany remarks that whilst it has the *facies* of Tremoctopus, it does not possess the *characters* of that genus. This may be on account of its young age.

N. Atlantic Ocean; Sicily.

T. DUBIUS, Souleyet. Pl. 43, figs. 80, 81.

Body subovate, smooth; eyes large, prominent; arms short, unequal, palmate at the base.

Length, 6 mill.

This is also a juvenile form, not in condition for identification.

Near Mauritius.

T. GRACILIS, Souleyet. Pl. 43, figs. 82, 83.

Body rounded, smooth; head small; eyes large, prominent; arms graceful, the upper very long, lower short, connected by a web. Phosphorescent and with metallic reflections when living.

Length, 24 mill.

Probably a young animal, but distinguished from the preceding species by its well-developed web, connecting all the arms.

Long. 106° *W.*, *lat.* 8° *N.*, *Pacific Ocean.*

T. HYALINUS, Rang. Pl. 43, figs. 84, 85.

Body short, broad, smooth, oval, larger before than behind; aperture very large; head short; eyes large, prominent, subpedunculated; arms unequal, *not webbed*, as long as the body; order of length 1, 2, 3, 4. Diaphanous, whitish marked with red.

D'Orbigny says: "Without doubt the young of one of the species."

Atlantic Ocean.

T. QUOYANUS, Orb. Pl. 44, figs. 91, 92.

Body smooth, oblong, large; white, marked with red; head large, smooth; eyes large, prominent, without eyelids, blue above; two aquiferous pores between the eyes and two below. Arms elongated, unequal; order of length 1, 2, 4, 3; two dorsal pairs webbed together half their length.

Total length, 42 mill.; of body, 12 mill.; length of arms 1, 24 mill.; 2, 22 mill.; 4, 20 mill.; 3, 16 mill.

Lat. 24°–26° *N.*, *Long.* 30° *W.*, *Atlantic Ocean.*

T. VIOLACEUS, Chiaje. Pl. 43, figs. 86–90; Pl. 44, figs. 93, 94.

Body rather ovoid, truncated anteriorly, nearly smooth, violet; head short; aquiferous pores, four on the back of the head and six small ones near each eye; arms elongated, order of length 2, 1, 3, 4, two dorsal pairs flattened and webbed to their tips.

Total length, 33 mill.; length of body, 6·5 mill.; length of arms 2. 23 mill.; 1. 15 mill.; 3. 13 mill.; 4. 13 mill.

Mediterranean.

Genus **PARASIRA**, Steenstrup.

P. CATENULATA, Fer. Pl. 45, figs. 95–98.

Body very large, oval, smooth above, reticulate and tuberculate below; aperture large; head very short, scarcely distinct; inferior aquiferous apertures two; arms graceful, order of length 1, 4, 2, 3; scarcely webbed.

Total length, 75 mill.; length of body, 22 mill.; length of arms 1, 50 mill.; 4, 43 mill.; 2, 42 mill.; 3, 39 mill.

The flesh of this mollusk is tough and unwholesome, and for these reasons is not sold in the markets. The Genoese fishermen make of the skin of the body a sort of cap, whereof the reticulations serve as ornaments. It is called Pulpu sepia in Sardinia and Poupressa at Nice.

Steenstrup (Vidensk Meddel., 332, 1860) considers this the female of the next species, but more recent authors separate them.

Mediterranean.

P. CARENÆ, Verany. Pl. 45, fig. 99.

Body rounded, acuminate behind, smooth; head short; arms very unequal, order of length 4, 1, 2, 3, with thirty to fifty suckers; two aquiferous pores at the bases of the fourth pair of arms. *Mediterranean.*

OCYTHOE TUBERCULATA, Raf. The author expressly declares that this is not the animal of the Argonaut, as supposed by Leach, Gray and others. It is like Octopus, and weighs fifteen pounds. The two superior arms are winged (Binney & Tryon's Rafinesque, p. 94). It may be founded on *T. violaceus* or a similar species. *Mediterranean.*

Genus **HALIPHRON**, Steenstrup.

Described from a single arm found in the stomach of a shark. No species characterized.

Family III. ARGONAUTIDÆ.

Genus **ARGONAUTA**, Linn.

The shells of *Argonauta*, although numerous species have been described, are all referable to three groups, and may not exceed that number of distinct species. These types are:

1. That of *A. hians*. Ribs few and distant, keel broad.
   Here belong, besides the type, *A. Conradi* Parkinson, *cornuta* Conrad, *dispar* Conrad, *gondola* Dillw., *Owenii* Adams, *polita* Conrad and *Kochiana* Dunker.
2. That of *A. Argo*. Ribs numerous, closer; keel narrow.
   To the type species may be added *A. Gruneri* Dunker, *compressa* Bl., *expansa* Dall., *Nouryi* Lorois, *Pacifica* Dall., *fragilis* Parkinson and *papyria* Conr.
3. That of *A. nodosa*. Ribs numerous, *tuberculated*, keel rather narrow.

Within each of these groups species have been formed upon the presence or absence of lateral "auricular" extensions or horns of the edge of the aperture, but large suites of specimens show that this character is by no means constant, and that it exists indeed, in all stages of development. Dr. E. von Martens* who was the first to perceive this grouping and the non-specific character of the horns, has proposed to designate under each species four forms, viz.:—

a. *Forma mutica*. Aperture narrow, lateral edges straight.

b. *Forma obtusangula*. Ends of aperture margin forming an angle with the plane of volution.

c. *Forma aurita*. Ends of aperture margin produced into a spine at right angles to the plane of volution.

d. *Forma agglutinaus*. Margin of aperture angulated at its ends, but the angles *appressed to the spire*.

The animal of the Argonaut-shell, supposed at first to be parasitic in it, has received the generic name of *Ocythoe* given by Leach as from Rafinesque. The *Ocythoe* of the latter author, however, was not intended by him to apply to the animal of the *Argonauta*. At any rate the *Ocythoe* of Leach becomes a

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* Ann. Mag. N. Hist., xx, 3d ser., 1867.

synonym of *Argonauta*, Linn—a generic name given to the shell only, with 60 years priority.

There is considerable difference between the animals of *Argonauta tuberculosa* and *A. hians*. In *A. tuberculosa* the sac-like mantle is more ovoid and elongated; the head is narrower; the infundibulum is broader, shorter, and furnished at the upper and anterior extremity with two conical prolongations; the eyes are considerably larger and slightly more prominent; the tentacular arms are shorter in comparison, and of greater width, more particularly at their basal portions. The suckers are much larger, more prominent, and placed closer together. This species varies also considerably in color from *A. hians*. The extremities of the brachia are marbled with deep red-brown; and, in the other parts, are covered with large irregular, oval, reddish blotches, each margined with a dark color. The circumference of the suckers is marked with brown spots. The upper surface of the infundibulum is covered with pale pink, rather scattered, and irregular quadrate blotches, margined with a dark red-brown. The mantle, on the dorsal surface, is densely sprinkled with round and square spots of a chestnut-brown and crimson, of different sizes. The velamenta are minutely punctulated with crimson and red-brown, and have a more bluish tinge than those of *A. hians*. The under surface is mottled and punctulated with dark chocolate on the arms, and on the body, is marked with small, irregular, dark, red-brown spots.

In *Argonauta hians* the body is more globose, and broader from side to side, the head is much wider and the tentacles are narrower and more elongated. The suckers are less elevated, smaller in comparison, and situated at a greater distance from each other. The mantle is covered with round spots and longitudinal linear markings of a bright crimson color. The entire animal wants the brown, dark appearance produced by the markings of *A. tuberculosa*, and is of a lighter tinge and more delicate appearance.*

The Argonaut or Paper Sailor is the Nautilus of the ancients. The pretty fable of the Argonaut, raising her velamentous arms, sail-like to catch the breeze, has been illustrated in both

* A. Adams, Narrative of Voy. Samarang, ii, 526, 1848.

prose and poetry by classical and modern authors: including in the former Aristotle, Ælian, Oppian, Athenæus, Pliny—and among modern poets, Pope and Byron.

Learn of the little Nautilus to sail,
Spread the thin oar, and catch the driving gale.

—POPE.

Light as a flake of foam upon the wind,
Keel upwards from the deep emerged a shell,
Shaped like the moon ere half her orb is filled;
Fraught with young life, it righted as it rose,
And moved at will along the yielding water.
The native pilot of this little bark,
Put out a tier of oars on either side,
Spread to the wafting breeze a twofold sail,
And mounted up and glided down the billow
In happy freedom, pleased to feel the air,
And wander in the luxury of light.

—*Pelican Island.*

The tender Nautilus who steers his prow
The sea-born sailor of this shell canoe,
The Ocean-Mab, the fairy of the sea
Seems far more fragile, and, alas, more free;
He, when the lightning-winged tornadoes sweep
The surf, is free, his post is in the deep,
And triumphs o'er the armadas of mankind,
Which shake the world, yet crumble in the wind.

—BYRON.

"Once as a sailor-shell I sported o'er
The azure wave: but now on Smyrna's shore,
Cypris, I grace thy shrine—the darling toy
Of fair Selene and her childhood's joy.
If wandering winds breathed soft, my tiny sail
Was duly spread to catch the summer gale:
If golden calm upon the waters came
My nimble feet were oars; and hence my name:
I cast myself on Julis' shore, that thou
Mightst glory, Cypris, in the maiden's vow.
No radiant Halcyon now with azure crest
Will seek my chambers for its sunny nest.
Thank fair Selene, then, whose virtues grace
The city of her proud Æolian race."

—CALLIMACHUS.*

* The above translation is from the Narrative of the Voyage of the Samarang, ii, 526, and is from the pen of Ernest Adams. In explanation of the subject it is stated that it was the custom of the Greek girls, on arriving at years of discretion, to consecrate to Venus the playthings of their childhood.

A living Argonaut was captured at Long Branch, New Jersey, by a fisherman, in August, 1876. It was kept alive for eight or nine days and made feeble attempts to swim in its narrow confinement.—*Am. Nat.*, xi, 243.

The occurrence of the Argonaut on the Florida coast, in one instance with the animal entire, is mentioned in *Am. Nat.*, xii, 397. The writer of the notice goes on to say that "in the Indian Ocean he has *seen* it in calm weather sailing on the surface, as described by old writers, but discredited by closet naturalists of these days." What became of the shell, when the vela were used as sails?

A beautiful specimen of *Argonauta compressa*, Blainville, in the cabinet of the Boston Society of Nat. Hist., is the largest known Argonaut shell. Its diameter is 10 inches.* It cost its donor, Col. Thos. H. Perkins, $500.—*Bost. Soc. Proc.*, v, 370.

Dr. H. Müller observes that the female Argonaut appears periodically in great numbers at Messina during the spawning season, but at other times her usual habitat is at the bottom in deep waters. The male is always very small, not exceeding an inch in length and is rarely met with: its hectocotylized arm is detached during coition and is found in the mantle of the female, where it enjoys a prolonged separate life, although unprovided with digestive organs. The young female an inch in length, *has no shell;* it is developed later.

In South Australia, at certain seasons of the year, during the prevalence of strong northerly winds, the shells of the female Argonaut are washed ashore in considerable numbers. Many of these shells contain the animal in a living state; but they soon fall a prey to the sea-gulls by whom they are greedily devoured.†

1. *Group of A. hians.*

A. HIANS, Solander. Pl. 46, figs. 100–102.

Animal small; head long; ventral aperture large; aquiferous openings two; arms short, unequal, order of length 1, 2, 3, 4; the webbed arms small, thick.

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* In same Proceedings, v, 35, Dr. Gould states the measurements of this specimen to be 11¾ by 7½ inches.

† Angas, On the molluscan fauna of South Australia, Proc. Zool. Soc., 156, 1865.

Shell with distant ribs, laterally compressed tubercles on the carina; surface smooth, polished.

Pliocene of Piedmont (not living in Mediterranean Sea); *So. Atlantic Ocean; China.*

I figure the typical *A. hians* (fig. 101), from Adams and Reeve, Voyage Samarang, and the eared form (*A. gondola*, Dillw., figs. 100, 102), with its animal.

A. Owenii, Adams and Reeve. Pl. 46, figs. 103–105; pl. 47, figs. 106, 107.

The ribs are somewhat closer and the tubercles on the carinæ are sharper and not laterally compressed as in *A. hians;* the surface is shagreened.

S. Atlantic Ocean.

A. cornuta, Conrad (figs. 104, 105), is an eared form of the same species. *A. dispar*, Conrad (106, 107), differs only in the unusual development of some of the lateral carinal tubercles, and in a portion of the back being tuberculate—neither of them specific characters.

A. Conradi, Parkinson.

Ribs rather distant, not furcate, long and short alternately, portion of the back studded with small tubercles; tubercles on anterior and posterior thirds of carinæ small, nearly obsolete; on the middle third of each carinæ, seven very large tubercles, broad at the base, laterally compressed. Aperture angled, spineless. Surface shagreened.

This species has never been figured; it is not apparently very distinct from *A. Owenii*, and perhaps, by its laterally compressed tubercles, may unite that species with *A. hians.*

New Nantucket, Pacific Ocean.

A. Kochiana, Dunker. Pl. 47, figs. 108–110.

Differs from *A. hians* in the ribs being closer and less prominent; from *A. Owenii* in the tubercles on the carinæ being but little prominent and finally becoming obsolete, and in the surface of the shell being polished. Probably all these forms should be referred to *A. hians.*

Chinese Sea.

A. Nouryi, Lorois. Pl. 50, figs. 126, 127.

Shell small, elongate, the sides swelled, rather closely undulately ribbed; carinæ closely tuberculate; the inter-carinal space broad and covered with small tubercles. Greatest diameter $2\frac{1}{4}$, least $1\frac{1}{2}$ inches.

Equatorial Pacific from Marquesas Isles to near Peruvian Coast.

This species appears very distinct from all others; it unites the wide whorls and broad back of the *A. hians* group with the fine ribs and carina-tubercles of the *A. Argo* group, and it differs from all in its very elongated form and the numerous tubercles on the back. The latter are present on three specimens before me, and are shown in one of Dunker's figures, although he does not describe them.

2. *Group of A. Argo.*

A. Argo, Linn. Pl. 47, figs. 111–115; pl. 48, figs. 116–119; pl. 49, figs. 120–123.

Animal, body oblong, smooth; eyes large, prominent; arms unequal, order of length 1, 4, 2, 3; the dorsal pair elongate, second and third pairs without any internal groove, the third pair depressed their whole length; siphuncle united to the base of the arms by a lateral membrane.

Silvery white or yellowish or with rosy reflections, thickly punctate with red.

Shell compressed, with close prominent bifurcating ribs on the sides and sharp tubercles on the keels: aperture rather narrow. White, keels brownish.

Tropical Pacific, Indian and Atlantic Oceans; Gulf of California; Mediterranean; Cape of Good Hope.

The obtusely angled form appears to be the only one found in the Mediterranean, whilst that of the Indian Ocean (*A. compressa*, Bl.) is eared. Dr. von Martens mentions a "*forma agglutinans*" represented by a single specimen in the Berlin Museum, and this appears to be the same as *A. papyria*, Conrad (fig. 119), the locality of which is not known. Mr. W. H. Dall has described two Pacific Ocean forms which I strongly suspect to be identical with *A. Argo*. The first, which he calls *A. Pacifica* and which is common on the Californian coast at times, has an orange-colored animal, finely sprinkled with purplish dots, the arms 1. 2. 4. 3; the web extends along only one-half of the fourth pair, and is proportionally shorter than in *A. Argo;* there is also a slight difference in the arrangement of the lingual denticles; the shell is stated to be more ventricose with a different arrangement of sculpture and tubercles. Finally Reeve's fig. 2 *c.* (fig. 121) is referred to—doubtfully as an illustration. The Museum of the Academy possesses a specimen from Cumana, precisely like the above-cited figure (which represents a shell from the same locality), and which is assuredly *A. Argo.*

Mr. Dall calls his second species *A. expansa*, and cites the Gulf of California as locality. He appears to have seen but a single specimen, which he describes as differing from *A. Pacifica* in having ears or lateral expansions, and in sculpture. The Museum of the Academy possesses a specimen collected by W. M. Gabb at San Pedro, Cal. (fig. 120), which answers well to Mr. Dall's description, but is not separable from usual eared forms of *A. Argo.*

The Indo-Pacific *A. compressa*, Bl. (*A. maxima*, Gualt.), sometimes attains a considerable size.

I figure the Mediterranean or typical *A. Argo*, the auriculed *A. compressa*, the agglutinated *A. papyria* and the *A. Argo* of Reeve, fig. 2 *c.*, which *may* represent *A. Pacifica.*

A. FRAGILIS, Parkinson.

Shell with numerous milk-white spots. Sinus large, furnished with a callus, which is attenuated towards the edge of the lip, and is carried across the base of the aperture from one sinus to the opposite, in a flattened arch; upon this arch rests one side of the nucleus of the shell; which is not involuted like other species, but rises in a cylindrical form, a half-inch above the arch from which the inner side springs. Around this cylinder are a number of lines of growth; but it is not tubercled, and has the shape of the end of the finger of a glove.

In other respects this specimen answers to the description of *A. Argo.* I believe it to be a pathological specimen of that species. Many individuals of *A. Argo* show the milk-white spots given as one of the specific characters.

No locality.

3. *Form of A. nodosa.*

A. NODOSA, Solander. Pl. 50, fig. 124.

Animal, body acuminated behind; arms more webbed below than above, unequal; in the following order 1, 2, 4, 3; the second and third pairs keeled on the outer side; the second pair depressed.

Shell compressed, thin; sides with transverse rugæ, broken up into tubercles; tubercles of the keels rather sharp, elevated, and sometimes laterally compressed; margin with a spine or "ear" on either side.

A specimen in Coll. A. N. S. is of the form *obtusangula*, but the ear is usually well developed. The sides of this species are more convex and the back broader than in *A. Argo*.

*Brazil, New Zealand, Indian Ocean, Cape of Good Hope.**

A. GENICULA, Gould. Pl. 50, fig. 125.

Described from a single specimen obtained with a seine at Rio Janeiro. It was a female of rather large size, being six inches long, but without a shell. It differs from *A. Argo* in the web between the upper and lower pairs of arms being more distinct, the dotting of the surface finer, the vela more elongated with the surrounding cupules much less definite and extensive. From *A. tuberculata* (*nodosa*), it differs in having a much longer siphon, a greater number of cupules and different formed vela. The first pair of arms are described as having a joint-like flexure (probably accidental), and the general color is greenish, with chocolate spots surrounded with golden green annuli.

Brazil.

A. RUFA, Owen, has not been characterized sufficiently to assign it a place among admitted species.

S. Pacific Ocean.

OCYTHOE PUNCTATA, Say, is described from a single specimen with its shell found in the stomach of a dolphin, and said to be preserved in the collection of the Academy at Philadelphia. The specimen is no longer extant, and Mr. Say believing the

* A specimen with animal, alive, and another specimen of the shell, in perfect condition, came ashore on the New Jersey Coast in 1876 and 1877.—LOCKWOOD, in *American Naturalist.*

animal to be parasitic did not deem it necessary to mention the characters of its shell, so that I am unable to identify the species with any certainty.

Family IV. LOLIGINIDÆ.

Genus **LOLIGO**, (Pliny) Lamarck.

The calamaries are good swimmers; they are found in all parts of the world. A liassic species is described. Owen mentions that the pens are sometimes duplicated in old specimens, several being found packed closely, one behind another. The suckers on the margins of the projections of the buccal membrane are doubtless additional prehensile organs very useful in assisting in holding the food to the mouth. There appear to be two types of form in the gladius or internal shell; that in which the wings are expanded, with convex margins, and that in which they are narrow, with nearly straight margins. Dr. J. E. Gray has made two divisions of the first type; those wings which are very broadly expanded falling into the first, those less broad, with consequently more acute apex, into the second. Besides that these divisions are entirely arbitrary as to their limitations, a sexual character is here involved: the females of some species would go into the first division, whilst the males of the same species possess a shell of the second division. Several of Dr. Gray's species are founded partially on differences in the shape of the gladius, and it may therefore be suspected that he has unnecessarily increased the number of species. Considerable stress has been laid upon the relative size and form of the fins in discriminating species, as well as some other differences of proportion, which, so far as I have had opportunity of studying from numerous examples from our own coast, are extremely variable; being due to sex, to difference of age, etc. I have grouped together species which appear to me to possess many common, and few and unreliable distinctive characters, and must leave to the future the settlement of their definitive relationships.

The so-called artificial eyes of the ancient Indian mummies of Arica, Peru, are, according to Tschudi,* the dried eyes of *Loligo gigas* inserted in lieu of the natural organs.

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* Sitz. K. Akad. Wien., xxxiv, 361, 1859.

A. Buccal membrane with seven projections, the margins of which are usually armed with suckers.

** Shell pennate, wings with convex margins.*

L. BREVIPINNA, Lesueur. Pl. 51, figs. 128–130.

The very narrow fins form the principal character of this species; but I have seen specimens which apparently connect it with *L. Pealii*, Lesueur. It is considered by several good authorities to = *L. brevis*, Bl., but that species is much more closely allied to the typical *L. Pealii*. If the whole group of American species be united into one, *L. Pealii* will have priority over all other names. *L. brevipinna* is common on the southern Atlantic coast of the United States. It has been captured as far north as Delaware Bay.

L. HEMIPTERA, Howell. Pl. 51, figs. 131, 132.

The type specimen is small and exhibits various evidences of juvenility. There is a difference of form in the gladius, and it may be distinct from the above. Howell says that it is not found north of the coral reefs.

Florida, Gulf of Mexico.

L. BREVIS, Blainv. Pl. 52, figs. 143, 144.

Distinguished by its short, nearly rounded fins. The figure represents a typical individual, and it appears to have better developed fins than *L. brevipinna*, and to differ from *L. Pealii* by these being rounded in outline instead of rhomboidal; but I have examined specimens in which the form of fins is intermediate, so that it is very difficult to place them.

Brazil.

L. PEALII, Lesueur. Pl. 51, figs. 133–140.

The fins in typical forms are rounded rhomboidal, well developed; the body is rather short, stout; the skin is beautifully punctate with close red spots which are crowded along the back. The curious dentition of the cups of the sessile and tentacular arms is shown by our figures. Verrill has figured the development of this species in Report of U. S. Fish Commissioner for 1873. He says that numbers of the free-swimming young of this species were often found in the stomach of the red jelly-fish.

I have already described and figured the eggs of this species. The animal attains the length of half a foot, ordinarily.

Atlantic Coast of U. S. from Maine to S. Carolina.

L. punctata, De Kay (fig. 133), does not appear to differ.

L. PALLIDA, Verrill. Pl. 52, figs. 141, 142.

The pale skin of this species, its distant spots, its "unusually pale and gelatinous" appearance, are insisted on as prominent characters. I find nothing in the detailed description to induce me to regard it as essentially different from *L. Pealii.* I have specimens, apparently referrible to this form, not far from a foot in length. Mr. Verrill says that "these squids are eagerly devoured, even when full-grown, by many of the larger fishes, such as blue-fish, black-bass, striped-bass, etc. When young they are preyed upon by a still larger variety of fishes, as well as by the jelly-fishes, etc." "It is often taken in the seines in large numbers with menhaden, upon which it probably feeds."

Long Island Sound.

L. CARDIOPTERA, Péron. Pl. 52, figs. 145–149.

D'Orbigny, Gray and others have placed this species in the genus *Onykia*, but Souleyet has examined the type specimen in the Museum at Paris and declares that the tentacular arms have no hooks, and that it is a true *Loligo.* I suspect it to be a young *L. Pealii*, and that *L. plagioptera* of Souleyet (figs. 148, 149) is a still younger state of the same species.

Central and South Atlantic Ocean.

L. BRASILIENSIS, Blainv. Pl. 53, figs. 154–160; pl. 54, fig. 161.

The tentacular suckers have equal serrations on their rings; otherwise the animal does not appear to differ from *L. Pealii.* In this distinctive character, however, it is like *L. Gahi.* The shell is narrower, however, and in the typical figure in Orbigny's work is represented with straight margins to the wings, whilst that of *L. Poeyanus*, considered a synonym, has narrow wings with convex margins.

Cuba, Brazil.

L. EMMAKINA, Gray.

Body oblong, rounded behind; fins half as long as the body, subrhombic; second and third pairs of sessile arms larger, with much larger suckers; tentacles with numerous small cups and smaller ones at the top. Shell lanceolate, thin, with a black central ridge; anterior part broad, one-fourth the length.

Not figured.

Brazil.

L. Gahi, Orb. Pl. 52, fig. 150; pl. 53, fig, 153.

This is another species of the *L. Pealii* group, from which it differs (as does *L. Brasiliensis*) in the serrations of the horny rings of the suckers on the tentacular arms being regular in size instead of alternately larger and smaller. The name is that vulgarly applied to the species by the Chilian fishermen and is of supposed Inca origin. The species is used for food as well as bait, and is a highly esteemed delicacy. Specimens in Mus. Phila. Acad. said to come from the Sandwich Islands, agree well in the dentition of the rings with this species.

Chili.

L. subalata, Gervais and V. Bened. Pl. 53, figs. 151, 152.

Placed by error in the genus *Rossia*, Messrs. Eydoux and Souleyet show that this is a true *Loligo*. Their figure represents only a few large suckers in two rows on the tentacular clubs, but the text speaks of numerous smaller ones, as is usual in the genus. The suckers of the sessile arms have rings without serrations.

Indian Ocean, Manilla.

L. Duvaucelii, Fer. and Orb. Pl. 54, figs. 162–164.

Body oblong, elongate, with rhombic fins half as long; third pair of sessile arms largest, compressed and externally finned; cups of ventral arms unequal, the rings with eight or nine blunt truncated teeth; clubs of tentacular arms much enlarged, the rings of the cups with distant, acute teeth. Shell pennate, stem broad. Gray remarks that this may be the young of his *L. Chinensis*.

Indian Ocean.

L. Hardwickei, Gray.

This species has not been figured. The fins are said to be nearly two-thirds the length of the body, rounded on the sides; tentacular arms with numerous small cups, with smaller ones in four rows at the tip. Shell with very broad wings. Like *L. brevis* but fins are longer; differs from *L. Duvaucelii* in the fins being longer, and the shell broader, with a narrow stem.

Indian Ocean.

L. CHINENSIS, Gray.

Body subcylindrical, acuminated behind, with rhomboidal fins. Rings of the cups of the ventral pair of arms with many close, acute teeth; tentacular arms with numerous rather large cups and some rather small ones at the tip, rings with distant teeth. Shell broad-lanceolate with a short, broad stem. Eaten in Canton.

Not figured.

China.

L. SUMATRENSIS, Fer. and Orb. Pl. 58, figs. 190, 191.

Body short, cylindrical, attenuated behind; fins regularly rhomboidal, truncated in front, angles rounded, nearly half the length of the body; arms moderate; tentacles very long and slender. Shell oblong, spoon-shaped; upper part rather narrow and produced. Placed by Gray in his genus *Teuthis*, but evidently a true *Loligo*.

Sumatra.

L. VULGARIS, Lam.

From this common European species have been separated by the minute perception of modern naturalists, a number of so-called specific forms, the distinctness of which appears to me to be problematical. The characters, which are comparative, may be individual only, in their strict limitation, or they may, perhaps, indicate varieties or even sub-species. I give the table of discriminative characters constructed by Lafont, and proceed with the descriptions of these forms.

A. Fins shorter than half the length of the body.
L. ALESSANDRINII, L. MENEGHINII, L. PULCHRA.

B. Fins longer than half the length of the body.

* Cups of the tentacles very unequal.

Eye small. L. AFFINIS.

Eye moderate.
L. BREVICEPS, L. NEGLECTA, L. MICROCEPHALA.

Eye very large. L. VULGARIS.

** Cups of the tentacles nearly equal.

Eye small. L. FORBESII.

Eye very large. L. MACROPTHALMA.

L. PULCHRA, Blainv. Pl. 54, figs. 165–167.

This species attains the length of 3 inches and is supposed to be adult at that size. The very small size of its fins constitutes its principal character.

Mediterranean, Mouth of the Loire, etc.

L. ALESSANDRINII, Verany. Pl. 57, fig. 180.

Body oblong, cylindrical, rounded behind; fins about two-fifths the length of the body, posterior, rounded; clubs of tentacles with large external suckers and very small middle ones. Shell not observed. Length, about 3 inches.

Differs from *L. pulchra* by its rounded fins.

Messina.

L. MENEGHINII, Verany. Pl. 57, fig. 181.

Body oblong, acuminated behind; fins posterior, rounded, scarcely half the length of the body; tentacles long, clubs but little developed, with two rows of very small suckers. Shell not observed. Length, about 3 inches.

Differs from *L. pulchra* by its body acuminated behind and rounded fins; from *L. Alessandrinii* by the former character.

Messina.

L. AFFINIS, Lafont. Pl. 55, fig. 169.

The male only, of this species is known. The narrow, cylindrical body, unequal cups of the tentacular clubs and obtusely rhomboidal, large fins form its principal characters. 6 to 8 inches.

Bay of Biscay.

L. MICROCEPHALA, Lafont. Pl. 55, fig. 170.

Head very small, scarcely more than half the diameter of the body, eyes moderate, fins long, obtusely rhomboidal; clubs with five pairs of large cups and numerous smaller ones.

Attains a length of 2 feet.

Bay of Biscay.

L. BREVICEPS, Steenstrup. Pl. 55, fig. 168.

Differs from *L. vulgaris* by its shorter arms and smaller head. It is the northern form of that species. Length of body, 1 foot; of tentacles, 6 inches. The dentition is the same in both species.

This appears to me to be very like *L. microcephala*.

German Ocean; Baltic Sea.

L. NEGLECTA, Gray. Pl. 55, fig. 171.

Body oblong, subcylindrical; fins two-thirds the length of the body, rhombic, rounded on the sides; tentacular arms with eight or nine very large cups in two rows, and small ones at the ends. Shell lanceolate. A figure of *L. vulgaris* in Fer. and Orb. (t. 8, f. 1, 2) is cited for this species; and also by Lafont in his description of *L. Moulinsi*. The latter author makes the cups of the tentacles nearly equal in size, but Gray more accurately describes d'Orbigny's figure.

Southern Europe, Atlantic and Mediterranean.

L. VULGARIS, Lamarck. Pl. 56, figs. 172–177.

Body large, attenuated behind; eyes large; fins nearly three-fourths the length of the body, rhomboidal, the angle well pronounced; third pair of arms dorsally webbed; tentacular clubs long, the middle suckers comparatively very large.

Length, 8 or 10 inches.

This is retained by most authors as the Lamarckian type in the division of the species.

Mediterranean; S. Atlantic Coast of Europe.

I figure the shell of the male, as well as the wider shell of the female of this species in order to show the great difference of form between them.

L. FORBESII, Steenstrup. Pl. 56, fig. 178.

Body much attenuated behind; eyes small; fins about two-thirds the length of the body, with well-pronounced external angles; arms rather long; clubs of tentacles short, with cups of nearly equal size. 8 or 10 inches.

This is the *L. vulgaris* of British authors.

Seas of Northern Europe, Bay of Biscay, etc.

L. MACROPTHALMA, Lafont. Pl. 56, fig. 179.

Body attenuated behind; eyes enormous, close together; head narrowed between the eyes and base of the arms; fins two-thirds the length of the body, angles well pronounced; clubs short and carrying nearly equal suckers. Length, 10 to 12 inches. Close to *L. vulgaris*, but differing by its tentacular cups of nearly equal size.

Bay of Biscay.

L. Reynaudii, Fer. and Orb. Pl. 57, fig. 182.

Body cylindrical, acuminate behind; fins more than two-thirds the length of the body, obtusely rhomboidal; sessile arms short, unequal, second, third and fourth pairs externally carinated, cups with acute teeth on higher side, diminishing in size to the other side; tentacles large, cylindrical, the suckers very unequal, ten or twelve middle ones very large, with smooth rings, the smaller lateral ones oblique, with acute teeth. Shell narrow. Closely allied to *L. vulgaris*.

Cape of Good Hope.

L. tricarinata, Gray.

Animal not observed. Shell lanceolate, central groove deep; blade with a slight raised ridge from the apex to the front part of the outer edge, near the commencement of the shoulder, producing three distinct keels on the convex side of the tip; upper part of stem one-fifth of the length. Length, 16 inches.

Isle of France.

Differs from all other shells of the genus by its large size, and the oblique groove from the tip to the upper margin. Not figured.

L. Australis, Gray.

Body oblong, subcylindrical; fins rhombic, half the length of the body; tentacular arms with many moderate-sized cups disposed in four rows, and with numerous smaller cups forming four rows at the tip. Shell broad, lanceolate, blackish-brown; upper end rather broad. Not figured.

Australia.

* * *Shell lanciform, with narrow, straight-margined wings.*

L. Plei, Blainv. Pl. 57, figs. 183, 184.

Body very narrowly elongate, attenuate toward the end; fins rhomboidal, two-fifths the length of the body; sessile arms very short, the oblique suckers with toothless rings; tentacles rather short with small clubs covered with unequal cups, rings of the largest ones smooth and toothless, of the smaller ones with acute points, of the small side cups very oblique with long teeth on the higher side. Shell elongate, very narrow, with three longitudinal grooves.

The shell is very like that of *L. Brasiliensis* (if the figure given in Fer. and Orb., which I have copied, is correct), but the animal is very different in its proportions. It is the narrowest species known in proportion to its length.

West Indies.

L. Bleekeri, Keferstein. Pl. 57, figs. 185, 186. Animal not described. The hectocotylized fourth left arm and a fourth right arm, as well as a shell are figured, the latter about 5 inches in length.

Japan.

B. Buccal membrane without projections or suckers.

Subgenus **Teuthis**, Gray.

L. media, Linn. Pl. 58, figs. 187–189.

Body subcylindrical, narrowly attenuate behind, and in the adult males produced beyond the fins; fins subcordiform; sessile arms with the oblique rings armed with blunt close teeth on the higher side; tentacular arms long, the sucker rings of the clubs with very close blunt teeth; siphon not valved. Shell lanceolate, broad, narrow in front.

Europe.

This species, known to Aristotle and the ancients, is highly esteemed for food; at Genoa it bears the local name of Totaneto, and in Italy generally is called Calamaretto.

Imperfectly known and doubtful species.

L. Hartingii, Verrill. Pl. 60, figs. 194, 195.

Harting described in the Trans. of the Royal Acad. of Amsterdam, in 1860, the buccal parts and some detached suckers of a gigantic cephalopod, preserved in the Utrecht Museum; locality unknown. He erroneously identifies these fragments with *Architeuthis dux* of Steenstrup, but Verrill has shown (*Am. Nat.*, ix, 85) that the dentition and the cupules are those of a *Loligo*, for which he proposes the above name.

I figure the buccal mass and a sucker, actual size, to show the immense dimensions that this creature must have attained.

L. Bouyeri, Crosse and Fischer. Pl. 59, fig. 193. This is the gigantic cephalopod encountered by the French steamer Alecton, near Teneriffe, an account of which we have already given

(p. 87). The figure obtained by an officer of the vessel during the three hours' encounter with this animal, together with a few details, suffices to show that it was a *Loligo*, although the tentacular arms are not represented. No specific characters were available to Messrs. Crosse & Fischer, and like *L. Hartingii*, with which it may be identical, its distinctive character is its size.

L. MINIMA, Fer. Pl. 58, fig. 192.

Body smooth, oblong, conical; fins very small, at the end of body, semicircular, far apart; sessile arms short, rather unequal, cups in two lines; tentacular arms long, cylindrical, scarcely enlarged at the end, with two rows of small, alternate, peduncled cups.

African Coast.

Too young for recognition.

L. OSOGADIUM, Raf. *Mediterranean.*

L. LANCEOLATA, Raf. *Mediterranean.*

? L. (ANISOCTUS) PUNCTATUS, Raf. *Atlantic Ocean.*

? L. (ANISOCTUS) BICOLOR, Raf. *Atlantic Ocean.*

The above have not been sufficiently characterized. The genus *Anisoctus* is said to have the aspect of a *Loligo*, an internal shell, but only eight arms. No such animal is known, and probably the tentacles were withdrawn or wanting to the specimens seen by Rafinesque.

L. CARUNCULATA, Schneider. *Gulf of Guinea.*

Genus **LOLIOLUS**, Steenstrup.

Loligo hemiptera, *L. brevipinna*, and other Loligines with blunt extremity and round fins, may perhaps belong to this small group, which is not widely separated by its characters from *Loligo*.

L. TYPUS, Steenst. Pl. 60, fig. 196.

Body short, blunt behind; siphon short and broad; lateral arms with large suckers; tentacles long, the clubs not larger, with very small suckers. Shell with broad expansions, and a sharp keel on the shaft.

Habitat unknown.

L. AFFINIS, Steenst. Pl. 60, fig. 197.

Fins more developed than in *L. typus*, arms proportionally shorter, with small suckers on the lateral arms. Shell with broad expansions, but the central shaft broader and not keeled.

Indian Ocean.

L. STEENSTRUPI, Dall.

Animal in general form much resembling *L. typus;* arms very short; tentacles from two to three times the length of the arms, lanceolate at the ends, with three rows of cupules. Color yellowish-white, with round spots and ocelli of various shades of purple; a large purple blotch behind each eye. Pen deeply grooved in the middle. Length, 1·7 inch. Not figured.

Gulf of California.

Genus SEPIOTEUTHIS, Blainv.

* *Buccal membrane provided with cups.*

† *Shell lanceolate, the wings thickened on the margins.**

S. GUINENSIS, Quoy and Gaim. Pl. 61, figs. 198–200.

Body oval, oblong; fins very broad, fleshy, most dilated behind the middle of the body; sessile arms slender, elongate, unequal, order of length 3, 2, 4, 1; cups depressed, oblique, rings with strong, curved, distant teeth, longest on the highest side; tentacles with large, blunt clubs, the cups rather oblique, in four rows, and the rings of the larger central ones narrow, with very distant teeth. Length, 1·5 feet.

New Guinea; Vanikoro.

Distinguished from all other species by having a line of large dark round spots on the superior surface of the fins.

S. AUSTRALIS, Quoy and Gaim. Pl. 61, figs. 201–205.

Body oblong, cylindrical, truncated in front, acuminated and blunt behind; fins very broad, fleshy, subrhomboidal; sessile arms elongate, unequal, order of length 3, 4, 2, 1; tentacular arms very strong, compressed, their clubs large, with very large cups, the rings of which have very distant truncated teeth. Violet rose-color. Length, $2\frac{1}{2}$ feet.

Australia.

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* I have some doubt whether either this character or the presence of cups on the membrane is of specific value; if it is not, several species which I have separated by these differences must be united.

S. Mauritiana, Quoy and Gaim. Pl. 61, figs. 208, 209; pl. 62, fig. 206; pl. 64, fig. 207, 210.

Body cylindrical, acuminated; fins narrow, widest at two-thirds the length of the body; sessile arms unequal, order of length 3, 4, 2, 1; the cups oblique, the rings with a number of acute, hooked, curved teeth; tentacles slender; the cups rather oblique, with acute, distant, hooked teeth. Length, 17 inches.

Mauritius.

S. Madagascariensis, Gray.

Body oblong, rounded behind; fins broad, rounded; cups of tentacular arms unequal, four-rowed; labial membrane with a single cup at the tip of each angle. Shell lanceolate, rather broad, upper part rather broad, blackish.

Not figured; the description is sufficiently indefinite.

Madagascar.

S. arctipinnis, Gould. Pl. 62, fig. 211.

Body elongate, ovate-lanceolate; fins with rounded outlines, broadest behind the middle; head rather narrow; sessile arms short, stout, order of length 2, 4, 3, 1; tentacles long as the body. Color brownish-purple with red dots.

Length of body, 6 inches; total length, 16 inches.

Sandwich Islands.

Very closely allied to *S. Mauritiana*, but differs in the formula of the arms; it is also very close to the next species, but besides the formula, there is a difference in the shell, which has thickened margins.

† † *Shell lanceolate, the margins of the wings not thickened.*

S. Lessoniana, Fer. and Orb. Pl. 62, fig. 212; pl. 64, 213.

Body elongated, violet-spotted; fins dilated posteriorly; head broad, ear crests thick, broad; sessile arms, order of length 3, 4, 2, 1, their cups oblique with distant, acute teeth; tentacles bluntly clubbed, the cups large, very oblique, and armed with acute, distant, curved teeth. Length, nearly 3 feet.

New Guinea; New Zealand; Java; Malabar.

S. Loliginiformis, Leuckart. Pl. 62, fig. 214; pl. 64, fig. 215.

Distinguished by its fins being wider posteriorly. *S. Hemprichii*, Ehrenburg, from the same locality (not figured), has a similar character: they are probably identical, and may prove to be synonymous with *S. Lessoniana.*

Red Sea.

* * *Buccal membrane without cups.*

† *Shell very thin, margin of wings not thickened.*

S. SEPIOIDEA, Blainv. Pl. 63, fig. 216.

Body ovate, oblong, violet-spotted, acuminate behind; fins commencing some distance behind, outline subrhomboidal; sessile arms subulate, slender, order of length 3, 1, 4, 2, the dorsal pair compressed, the others depressed, the rings broad, with long, acute teeth; tentacles slightly clubbed, the cups in four lines, of which those of the two central are largest. Shell very thin, transparent, very broad, lanceolate; central ridge broad above, narrow below. A small species, attaining 4 inches.

West Indies.

† † *Shell with margin of wings thickened.*

S. SLOANII, Leach.

Fins widest in middle of body. Shell with broad wings. Not figured.

West Indies.

S. OVATA, Gabb. Pl. 63, fig. 217.

Body broad, bluntly pointed posteriorly; fins narrow, regularly rounded in marginal outline, widest in the middle; sessile arms, order of length 3, 4, 2, 1, laterally compressed, but slightly dilated at the club. Shell with broad wings.

West Indies.

Mr. Gabb distinguishes it from *S. Sloanii* by the margin of the shell not being thickened, but I find that the margin of his typical shell is thickened, and therefore it is very probable that it is the same species.

S. BLAINVILLIANA, Fer. and Orb. Pl. 63, fig. 218; pl. 64, figs. 219, 220.

Body cylindrical, attenuated but rounded behind; fins fleshy, very broad, broadest in the middle, margin outline well rounded; sessile arms long and slender, the rings oblique, with long, close, acute teeth; tentacles with moderate clubs and suckers, the teeth of the rings similar to those of the sessile arms. Shell lanceolate, very broad and thin; the wings broadest in the middle, strongly thickened on the margins towards the extremity. The thickening of the shell margin is not well represented in the original figure. Length, about 15 inches.

Java.

In form very like *S. Australis.*

** * * Species of which the buccal membranes are undescribed.*

S. BILINEATA, Quoy and Gaim. Pl. 63, fig. 221,

Body elongated, rather narrow; fins rhomboidal, very wide in the middle, the angle rounded; outline of body marked upon its dorsal surface by a blue line.

Australia.

S. MAJOR, Gray. Pl. 64, fig. 222.

Body subcylindrical, attenuated posteriorly; lateral pinnæ produced to the whole length of the body, extended in the middle. Length of body, 27 inches; of head, 6 inches.

Cape of Good Hope.

This looks very like *S. bilineata*, and also like *Thysanoteuthis Rhombus;* the very poor figure shows that the specimen is mutilated.

S. SINENSIS, Orb.

So named from a cephalopod referred to in Encyc. Japonaise. It is eaten broiled, by the natives. No specific characters given.

Japan.

Genus **TEUTHOPSIS**, Deslongchamps.

A few species known, from the lias of France and Wurtemburg.

T. BUNELLII, Desl. Pl. 65, figs. 223, 224. *Calvados.*

Genus **LEPTOTEUTHIS**, Meyer.

Only a single species known.

L. GIGAS. Meyer. Pl. 65, fig. 225. Oxford clay, *Solenhofen.*

Genus **BELEMNOSEPIA**, Agassiz.

The ink-bag, mantle and bases of the arms, as well as the horny shells of this animal, are preserved. Some of the ink-bags are nearly a foot in length, and are invested with a brilliant nacreous layer. So indestructible is this fossil ink that it is yet capable of use as Sepia. Nine species are found in the upper lias of Wurtemburg, Calvados and Lyme Regis.

B. LATA, Orb. Pl. 65, fig. 226. *Wurtemburg.*

Genus **BELOTEUTHIS**, Münster.

Münster described six species, which d'Orbigny afterwards recognized as varieties only, of a single form.

B. SUBCOSTATA, Münst. Pl. 65, fig. 227.
Upper lias, *Wurtemburg.*

Genus **PHYLLOTEUTHIS**, Meek and Hayden.

This genus is founded on an impression of the expanded part of a gladius in a mass of rock: it was evidently thin, and as no part of its substance remains, is supposed to have been corneous in texture. It looks very like *Beloteuthis.*

PH. SUBOVATA, M. and H. Pl. 65, fig. 228.
Upper cretaceous, *Moreau R., Dakota.*

Genus **PTILOTEUTHIS**, Gabb.

Elongate, sub-ovate, very thin, anterior end broadly angulated, no mid-rib; slipper either minute or wanting. Surface marked by numerous, irregular, small wrinkles, which radiate backwards and outwards, partly from the anterior end, and partly from an imaginary median line.

P. FOLIATUS, Gabb. Pl. 105. Neocomian, *California.*

Family V. SEPIOLIDÆ.

Genus **SEPIOLA**, Leach.

* *Body and head smooth beneath, cartilage of mantle narrow, linear, oblong. Typical.*

† *The sessile arms with two alternating rows of cups to their ends.*

S. SEPIOLA, Linn. Pl. 65, figs. 229–237.

Body oblong, smooth, rounded behind, flesh-color with blotches and spots of dark purple, paler ventrally; fins leaf-like, rounded, dorsal, and subcentral as to the length of the body; arms short, the lateral ones longest; the suckers of the ventral arms are crowded and four-ranked on their tips in the female; tentacles very long in the male, much shorter in the female. Shell with thickened margin. Length, 2 to 3 inches.

S. Rondeleti, Orb., is the male of this species, and I include here also *S. major* of Targioni-Tozzetti, as I cannot find distinctive characters of sufficient importance to separate three Mediterranean species, as the Italian author has done.

Mr. Alder says of it: "This is an odd fish, crouching generally at the bottom like a toad, with its great goggle-eyes half closed, and sometimes crawling along by means of its suckers, puffing the water through the funnel all the time. When it does take to smimming, it darts very quickly through the water, and is difficult to catch. When taken out of the water and placed on the hand, it had recourse to an odd mode of progression, turning two or three somersets in tumbler-fashion, first laying hold with its arms, turning over, and laying hold again until it managed to get back into the water." It is said, by Mr. Gosse, to burrow in the sand by blowing through its funnel, and using its arms, with their suckers, to remove small stones and gravel. They spawn towards the end of May or beginning of June. The eggs are arranged in the centre of a bluish gelatinous mass, as if around an axis, and fifteen to thirty of these masses, each containing from forty to one hundred and thirty eggs, are united, each by a basal stalk, to form a group attached upon some submarine body. The fry is hatched in twenty-two to twenty-five days They visit the Algerine coast in numerous troups during the month of May, for the purpose of spawning. In the Mediterranean it is found at depths of 60 to 200 mètres, where it lives in company with the Eledones. Largely consumed as food in Italy; it is much esteemed for the delicacy of its flesh.

All European Seas.

S. Oweniana, Fer. and Orb. Pl. 66, fig. 238.

Body elongate, ovate, rather pointed behind; fins very small, far apart, nearly circular; sessile arms elongate, slender, subulate, unequal, order of length 2, 3, 4, 1; tentacles very long and very slender, club small, crowded with minute cups.

Length, about 4 inches.

Habitat, Viti Isles. (Mus. Acad., Phila.)

S. JAPÒNICA, Fer. and Orb.

Body oblong; fins widened; cups of sessile arms in two alternating lines, with a clavate muscular tube between them; tentacles long, cylindrical, scarcely enlarged at the clubs, with very minute suckers. Not figured.

Japan.

† † *Sessile arms with eight rows of cups.*

S. STENODACTYLA, Grant. Pl. 66, fig. 239.

Body short, rounded behind; fins subcircular; head large; sessile arms thick and short, rather unequal; cups large, spherical, in seven or eight rows, rather irregularly disposed; tentacles long, slender, club indistinct, cups very minute or scarcely developed. Purple, darker spotted and cross-banded on the arms. Length to end of sessile arms, 3 inches.

Mauritius.

* * *Body and head tubercular beneath; internal cartilage of mantle broad, contracted in the middle* = SEPIOLOIDEA, Orb.

S. LINEOLATA, Quoy and Gaim. Pl. 66, fig. 242; pl. 67, figs. 240, 241, 243.

Head and body smooth above, strongly tubercular on the sides beneath, tubercles with horny centres; dorsal edge of mantle bearded; body short, rounded; sessile arms short, quadrangular, rather unequal, two upper pairs slenderer and shorter, and webbed at the base; cups hemispherical, in two alternate regular series on the base, and then small and in four series, their rings very high, with an external border; tentacles slender, lanceolate at the end, and with twenty series of very numerous, exceedingly small, crowded cups. Whitish, with longitudinal blue or opaque white lines. Length to end of sessile arms, $2\frac{1}{2}$ inches.

Jarvis Bay, Australia.

Doubtful species.

S. PENARES, Gray. Pl. 67, fig. 244. This species is the type of Gray's genus *Fidenas*, which does not seem to possess any distinctive characters to separate it generically from *Sepiola*, except that the suckers are long-peduncled, and the peduncles are constricted on the upper part. The specimen, in spirits, is described as "not good state, lost the pedunculated arms. Shell—? or none." I copy an original figure in H. & A. Adams' Genera.

Singapore.

S. LEUCOPTERA, Verrill.

"Species probably small, but the three specimens observed are probably not full grown. Body short, depressed, with the mantle smooth. Ventral surface in middle, with a somewhat flattened heart-shaped or shield-shaped area, surrounded, except in front, by a silvery white band, having a pearly or opalescent lustre. Eyes small, with round pupils. Fins large, in the living specimens nearly as long as body, broadly rounded; the posterior lobe reaches nearly to end of body, the anterior edge beyond front of mantle to the eye. The anterior edge of the mantle is emarginate beneath; above it is broadly attached to the head. Sessile arms short; upper ones shortest; third pair largest; tentacular arms slender, extending back to end of body. Upper surface of body thickly spotted with orange brown."

Length to base of arms, 14 mill., in alcohol; of mantle above, 8 mill.; breadth, 7 mill.; breadth across fins, 16 mill.

Gulf of Maine, 30 *miles E. from Cape Ann,*
110 *fathoms, muddy bottom.*

I am by no means satisfied that this is a *Sepiola*, and unfornately Prof. Verrill has neglected to describe the shell, which would have fixed its generic position definitely. Whatever genus it may belong to, however, the characters and proportions given above indicate decided immaturity in the specimens examined, and afford no valid reason for the supposition that the adult will prove to be distinct from the species already described.

Genus **ROSSIA**, Owen.

R. PALPEBROSA, Owen.

Body oblong; head nearly as large as the body, swollen at the eyes; fins placed anteriorly, contracted at their junction with the body; arms short, very unequal, order of length 3, 4, 2, 1, cups in two rows at the base, and in many rows at the end of the arms, similar in size; tentacles elongate, with very many minute suckers on the clubs. Total length, 5 inches.

Arctic Seas.

Owen thinks that the eyelids discovered in this species, and from which it derives its name, are a peculiar organization designed as a defense for the eyes against the spicular ice crystals, which, in the summer season, crowd the northern waters.

R. Molleri, Steenstrup.

Distinguished from *R. palpebrosa* by having very large suckers on the clubs.

Greenland.

R. macrosoma, Chiaje. Pl. 67, figs. 245, 246.

Body smooth, short, broad, rounded behind; fins thin, short, semicircular, larger in front; head short; arms subulate, rather compressed, elongated, unequal; order of length 3, 4, 2, 1; cups spherical, in two distinct rows at the base, and four at the tip, with large smooth rings; tentacles slender, cups at the base of the clubs large, diminishing in size and augmenting in number towards the end. Length, 5 inches.

Shell lanceolate, two-thirds the length of the body.

Great Britain to Mediterranean.

With this I identify, with Forbes and Hanley, *R. Jacobi*, Ball, described from Dublin Bay, Ireland. Steenstrup thinks these are females, and that the next species, *R. Owenii*, Ball, is the male of the same species; to this, I may add that *R. Panceri* of the Mediterranean Sea does not appear to me to be essentially different from *R. Owenii.*

The species is sedentary in habit, and is obtained by the fishermen in from 50 to 300 mètres' depth.

R. Owenii, Ball. Pl. 67, fig. 247.

Differs from *R. macrosoma* by the cups being large, on long peduncles, arranged in three rows, those of the centre row not half the size of the side ones; on the first pair of arms more numerous, more equal in size and smaller than on the other arms.

Northern Europe.

See remarks under preceding species.

R. Panceri, Tozzetti. Pl. 68, fig. 248.

Body subcylindrical, attenuated behind; fins subcentral, somewhat trapezoidal; basal suckers in two rows, afterwards in four rows, pedunculated; tentacula lost.

Mediterranean.

See remarks under description of *R. macrosoma.*

R. glaucopis, Lovén. Pl. 105.

Fins medial; arms slightly webbed, order of length, 1, 2 = 4, 3; suckers in two rows throughout; tentacula long, graceful, terete, the short clubs with numerous suckers, of which the lower ones are largest. Not figured.

Finmark, Shetland.

R. papillifera, Jeffreys.

Body stout; back of mantle, head and arms covered with small whitish pimples; arms stout, all except the ventral pair connected below by a strong web; suckers bead-like, pedicelled, in two series throughout, larger on lower part and middle of each arm, very small at the tips; tentacles rather thick, not extending below the middle of the mantle, clubs terminal and small, crested on each side, with numerous, small suckers. Length, 1·75 inch. Not figured.

North of Shetland Isles.

Dredged 60 to 100 fathoms. Seems to bear the same relation to *R. glaucopis* that *R. Owenii* and *R. Panceri* do to *R. macrosoma.*

R. Hyatti, Verrill.

Body subcylindrical, usually broader posteriorly, in preserved specimens, variable in form according to contraction, dorsal surface covered with small, conical, scattered, whitish papillæ, which are also found on the upper and lateral surfaces of the head and arms; those around the eyes largest; one on the mantle, in the median line, near the front edge is elongated. Fins moderately large, nearly semicircular, lobed in front, the centre of the fins being about the middle of the body. Siphon elongated, conical, with small opening. Head depressed, more than half the length of the body. Eyes large, lower eyelid more prominent but not much thickened. Sessile arms short, united at their bases by a short web, which is absent between the ventral arms; dorsals shortest; third pair longest and largest; second and fourth pairs about equal in length. Suckers numerous, subglobular, not very small; near the base of the arms they are biserial, there being usually four to six thus arranged in each row, then they become more crowded, forming about four rows, and very small and crowded towards the tips. Tentacles, in preserved specimens will extend back to posterior end of body, smooth, somewhat triquetral, the sucker-bearing portion bordered by a wide membrane on the upper, and a narrow one on the lower margin; the suckers very small, subglobular, crowded in about eight to ten rows in the widest portion.

Length from base of arms to posterior end, 40 mill.; of body, 25 mill.; of head, 15 mill.; of fins, 15 mill.; of arms, 1, 12·5; 2, 15; 3, 18; 4, 13 mill.; of tentacles, 40 mill.

Massachusetts Bay, off Cape Sable and Halifax, N. S. 50 to 100 fathoms; in September, with eggs, from the latter locality.

I give detailed description of this species because it has not not yet been figured: its close relationship to *R. papillifera* is apparent. As I have already intimated more than once, I believe that a larger acquaintance with the cephalopoda will result in a great reduction of so-called species; characters which are frequently detailed at length as of specific importance, will be found to be very variable. It is probable that both this and the following, *R. sublævis*, are synonyms of *R. papillifera*, and that the latter itself will fall into the synonymy of one of the older described species.*

R. SUBLÆVIS, Verrill.

Larger and relatively stouter than the preceding species, with the fins larger and placed farther forward, the front edge of the large, free lobe reaching nearly to the edge of the mantle. Head large and broad. Sessile arms more slender and less unequal in size than the preceding, and with the suckers arranged in two regular rows throughout the whole length. Anterior edge of mantle scarcely sinuous, advancing but little dorsally. Upper surface of head and body nearly smooth, but in the larger specimens with a few very small whitish papillæ, most numerous near the front edge of the mantle.

Length from base of arms to end of body, 46 mill.; of body, 31 mill.; of head, 15 mill.; of fins, 20 mill.; of arms, 16, 17, 20, 15 mill. respectively; of tentacles, 25 mill.

Taken with the preceding species, and is the more common of the two, in Massachusetts Bay. The differences may prove to be only sexual, but this cannot be determined without a larger number of specimens. See remarks under *R. Hyatti*.

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* Sars makes *R. papillifera* a synonym? of *R. glaucopis*.

R. DISPAR, Rüppell. Pl. 68, fig. 249.

Body ovate, rounded, rather tapering behind; fins rounded, rather behind middle of back; sessile arms rounded externally, upper ones slightly webbed together; cups in two series, small, globular, except on lateral third pair of arms, where they are very large, pedunculated; tentacles slender, tapering, the clubs scarcely marked, with very minute cups. Smaller than *R. macrosoma.*

Sicily.

Family VI. CRANCHIIDÆ.

Genus **CRANCHIA**, Leach.

C. SCABRA, Leach. Pl. 68, figs. 250, 251.

Body very voluminous, flask-shaped, head very small, with large eyes, surface of head and body thickly beset with small horny tubercles; fins very small, united by their sides; arms unequal, order of length 3, 2, 4, 1, with cups far apart on their margins; tentacles contractile, the cups smaller than those of the sessile arms. Shell very narrow, narrowed in the middle, expanded and acute at each end. Length, nearly 2 inches.

Congo, Africa; West Indies.

Oct. Eglais, Orb. (fig. 251), is the young of this species.

C. MACULATA, Leach.

Differs from the above by the skin being smooth, beautifully marked with black spots. Not figured.

Congo, Africa.

C. MEGALOPS, Prosch.

The body joined to the head by a pseudo-articulation (which is made by him a subgeneric character. *S.G. Owenia*). Eyes large; arms small, order of length 3, 2, 4, 1; tentacles long; fins lunate.

Genus **LOLIGOPSIS**, Lamarck.

* *Smooth. Typical Loligopsis.*

L. HYPERBOREA, Steenst.

Body smooth, elongated; with very narrow fins, half the length of the body, forming a lanceolate figure; arms 3, 2, 1, 4, in proportionate length, with large suckers; tentacles much shorter than in *L. pavo*, being only twice the length of the sessile arms. Not figured.

North Greenland.

L. PAVO, Lesueur. Pl. 68, fig. 252; pl. 69, fig. 253.

Body smooth, conical, elongated, spotted with red; fins terminal, short, soft, narrow, outline together heart-shaped, not notched in front; sessile arms short, slender, three upper pairs rounded; cups much depressed, broad, oblique, rings smooth exteriorly, inner edge divided into square teeth; tentacles slender, very long. Shell elongate, very thin, nearly gelatinous, attenuated anteriorly, lanceolate posteriorly.

Total length, including tentacles, more than 3 feet.

Arctic Seas to Madeira.

The figure (which is a copy of Lesueur's) represents an individual with mutilated arms. Pl. 26 of the second edition of Gould's "Invertebrata of Massachusetts," intended for this species, probably represents *Ommastrephes illecebrosa* Lesueur.

L. ELLIPSOPTERA, Adams. Pl. 68, fig. 254.

Body funnel-shaped, semipellucid; hinder part elongate, tapering; fins depressed, semicircular, rounded, outline together oblong; siphuncle very large; arms very unequal, comparative length 2, 3, 1, 4. Shell slender, penniform.

Length, including sessile arms, about 6 inches.

North Atlantic Ocean.

A single specimen only discovered, which was in bad condition, as the tentacles are neither figured nor described. Its distinctness from *L. cyclura* is very questionable.

L. CYCLURA, Lesueur. Pl. 69, fig. 225.

Body coniform; terminal fin orbicular; head small, eyes large, prominent; arms unequal, order of length 3, 2, 1, 4. Color bluish and red, with red spots, and remote transverse abbreviated lines and dorsal spots of black.

Total length, $5\frac{1}{2}$ inches.

Indian Ocean; Pacific Ocean, Lat. 37° S., long. 33° E.

D'Orbigny and Gray have placed with this species, *L. guttata*, Grant, the body of which has rows of tubercles, but Lesueur describes and figures a smooth species.

L. CHRYSOPTHALMOS, Tilesius. Pl. 69, fig. 256.

Body elongate, narrow, with a large, oval, dorsal, black spot. Scarcely an inch in length. Tentacles not observed. The dorsal spot may be a result of the aggregation of chromatophores in a state of irritation.

Japan.

L. ZYGÆNA, Verany. Pl. 69, fig. 257.

Body gelatinous, transparent, subcylindrical, tapering; fins half oblong, together nearly square, narrower in front, broader and sinuous behind; sessile arms, order of length 1, 2, 4, 3, dorsal pair webbed at base, rest free; tentacular arms with small cups scattered throughout their length. Shell not described.

Sicily.

A single specimen only known: its small size and pedunculated eyes indicate a very young animal. Its generic position is uncertain.

L. VERMICOLARIS, Rüppell. Pl. 69, figs. 258, 259.

Body very long, slender, gelatinous, transparent; neck long; fins together subcordate, with a lengthened posterior point; sessile arms with very small distant cups in alternate series, the ventral arms more than double the length of the others; tentacles very long, with long, narrow clubs, crowded with microscopic suckers. Shell very slender.

Sicily.

Three specimens only of this very curious form have been found; like the preceding, its generic position is very doubtful.

L. PERONII, Lam.

Body fleshy, oblong; the mantle sub-acute at the base, and inferiorly finned; mouth surrounded by eight sessile and equal arms.

South Seas.

A doubtful species; not figured.

Subgenus **Perotis**, Esch.

Sides with rows of acute tubercles; shell with solid tip.

L. GUTTATA, Grant. Pl. 70, figs. 259–264.

Body elongate, rather fusiform, attenuated behind; whitish, spotted with red, with a few black, round spots; with a dorsal ridge, and row of eleven acute, four-pointed tubercles, and many smaller ones on either ventral side of the body; fins semicircular, broad, together subrhomboidal; sessile arms large, conical, very contractile, unequal, proportionate lengths 3, 2, 4, 1; cups nearly spherical, rings oblique. Shell elongate, thin, very narrow anteriorly, lanceolate, rather dilated behind; tip very sharp, attenuated, solid. Total length, 6 inches.

Indian Ocean.

As already stated, D'Orbigny and Gray have confounded *L. cyclura*, Lesueur, a smooth form, with this very remarkable and distinct armored species: which is the type of *Perotis*, Esch.

L. Reinhardtii, Steenstrup.

Body with a toothed, cartilaginous band down the median line of the back; also two other toothed cartilaginous bands or ribs on each side of the body, which meet at an acute angle exactly at the points where the mantle is united with the funnel on each side; the proportions of the arms are 3, 2, 4, 1, and they only bear two series of suckers; the tentacles have four rows of suckers on the outer third, which are continued in a scattered arrangement over the middle third; the fins are terminally small and roundish.

Azores; Tropical Atlantic.

This is another remarkable species, and seems to differ from *L. guttata* in having two rows of tubercles instead of one on each side of the body. It has not been figured.

Family VII. CHIROTEUTHIDÆ.

Genus **CHIROTEUTHIS**, Orb.

The great cephalic development of the animals of this very restricted genus, the immense length of the tentacles and the peculiar armament of their clubs, and the gladius expanded at each end, form excellent distinctive characters from the Loligopsidæ.

C. Veranyi, Fer. Pl. 70, figs. 265–271.

Body smooth; fins semicircular, together heart-shaped; head large; sessile arms very large, rounded, acuminate, order of length 4, 3, 2, 1; rings of the suckers on the three upper pairs with very close acute teeth, longest on the broader side; tentacles twelve times as long as the body, with an occasional sucker, and with a lanceolate club covered with peculiar, long pedunculated suckers. Shell very narrow; the lowest part with the longest and broadest expansion.

Mediterranean.

C. Bonplandi, Verany. Pl. 70. figs. 272, 273.

Body elongate, conical; head moderate; fins half the length of the body, together rhomboidal; sessile arms subulate, with rounded tubercles at the end, unequal, order of length 3. 2. 1. 4; tentacles lost? Shell very narrow in the middle, narrow above and dilated below.

29° *N. lat.*, 39° *W. long.*, *Atlantic Ocean.*

Genus **HISTIOTEUTHIS**, Orbigny.

H. Bonelliana, Fer. Pl. 71, figs. 274–281.

Body short, obtuse; head very large; head, body and arms covered with scattered tubercles; sessile arms unequal, fleshy; fins semicircular, broad. Shell broad, lanceolate, with a second smaller shell placed on its interior face.

Total length, 400 mill.; length of body, 70 mill.

Mediterranean.

H. Ruppellii, Verany. Pl. 71, fig. 282; pl. 72, figs. 283, 284.

Body, head and arms granular; head large; second and third pairs of arms longer; first and fourth shorter. Shell oval, lanceolate, attenuated in front, acuminated behind; with a second smaller shell placed on its interior face.

Total length nearly three times that of *H. Bonelliana.*

Mediterranean.

H. Collinsii, Verrill.

A very large and handsome species, with a broad thin web extending between and nearly to the ends of the six upper arms. Tentacles about 2 feet long, slender, the club broad, oval, bordered by a membrane, and ending in a tapering tip, on the back of which is a keel enlarging backward to the end, where it forms a rounded lobe. The most expanded portion of the club bears five rows of suckers, with finely serrate rings; two rows contain much the largest suckers, four or five in each, the more central of the two rows containing four suckers larger than the rest. A row of small tubercular suckers, ranged singly or alternating two by two extends for about six inches along the stalks of the tentacles; and minute serrate suckers also cover the tip of the club, beyond its expanded portion. Sessile arms stout, three-cornered, tapering to slender tips, each bearing two rows of globular suckers, having a small, oblique opening, and few blunt teeth. The ventral arms are united together, near the base, by a web, which also unites to the main web, in the median plane. A narrow web, arising from the outer angles of the arms, also unites all the arms together for a short distance above their bases. Beak with very sharp black tips; a broad membrane, rising into six prominent angles, surrounds the mouth. Outer surface of head and arms covered with large, very slightly raised warts or tubercles, which are dark blue, with a whitish centre; a circle of them surrounds the eyelids. Color, between the warts, purplish brown, with dark brown spots and reddish specks; web and inner surface of arms uniform dark reddish brown; suckers yellowish white; tentacles light orange brown.

Length of tentacles, 24 to 25 in.; of arms, 1, 14 in.; 2, 17 in.; 3, 17·25 in.; 4, 14·25 in.

Off Nova Scotia.

Family VIII. THYSANOTEUTHIDÆ.

Genus **THYSANOTEUTHIS**, Troschel.

T. Rhombus, Troschel. Pl. 72, figs. 285–287.

Characters those of the genus.

Length of arms 3, 100 mill.; 2, 53 mill.; 4, 35 mill.; 1, 34 mill.; length of tentacles, 104 mill.; of head and body, 115 mill.

Messina.

Resembles the mutilated cephalopod from Cape of Good Hope, which Gray described as *Sepioteuthis major*. See fig. 222.

T. elegans, Troschel. Pl. 72, figs. 288, 289.

This is very much smaller in size, and the fins are much more rounded in outline.

Proportionate length of arms 3, 13 mill.; 2, 10 mill.; 1, 8 mill.; 4, 7 mill.; length of head and body, 19 mill. I think it probably the young of *T. Rhombus*.

Messina.

Family IX. ONYCHOTEUTHIDÆ.

The principal character of this family is the development of hooks upon the arms, as a means of prehension; they replace the sucking disks to a greater or less extent, according to the several genera. A few fossil forms occur.

Genus **GONATUS**, Gray.

G. AMŒNA, Moller. Pl. 73, fig. 290.

Body cylindrical, tapering, acute behind; fins rhombic, not one-third the length of the back.

Norway; Greenland.

Genus **ONYCHOTEUTHIS**, Lichtenstein.

These animals are solitary in habit, frequenting the open sea, and especially banks of gulf-weed. Some of the species have an immense geographical distribution; as *O. Banksii*, from the Arctic Ocean to the Cape of Good Hope and Indian Ocean. The peculiar arrangement of suckers, forming a circle at the base of each tentacular club, enabling the animal to use the two clubs in conjunction, when necessary, give an immense increase of power. They suggested the obstetric forceps of Professor Simpson.

O. BANKSII, Leach. Pl. 73, figs. 291–294.

Body very elongate, cylindrical, acuminate behind; head with postero-dorsal, longitudinal, small, prominent ridges; fins rhomboidal; sessile arms conic-subulate, winged on the back, unequal, in length 2, 3, 4, 1; cups with a fleshy excrescence, compressed, pear-shaped; tentacles very extensile, the clubs armed with a double series of hooks, of which the outer row is much the largest, with a basal and sometimes an apical group of cups. Shell dark brown, lanceolate, pennate, with a short central keel, thin. Ordinary length of body, 6 inches.

I unite a large number of nominal species under this name, the examination of numerous specimens and of the various figures having convinced me that their characters are illusory.

Distribution nearly universal; collected in all the oceans at numerous localities, equally in arctic and tropical waters.

O. Lichtensteinii, Fer. and Orb. Pl. 73, figs. 295–297.

Head large, with eight longitudinal postero-dorsal ridges; body elongate, narrowed posteriorly, produced; fins about one-third the length of the body, triangular-sagittate, narrowly produced behind; sessile arms in length 4, 3, 2, 1, externally webbed; tentacles as in *O. Bergii* (= *O. Banksii*). Shell with a long end-conus. Length, 16 to 18 inches.

Mediterranean.

The larger size, posteriorly produced fins, and different shell, will distinguish this species from *O. Banksii*.

O. Krohnii, Verany. Pl. 73, figs. 298, 299.

Body stout, cylindrical, acuminate behind; fins large, rhomboidal, half the length of the body; head with eight postero-dorsal ridges. Shell with a rather broad lamina.

Length, 1·6 inch.

Messina.

Notwithstanding differences of proportion, etc., it may be that this is the young of *O. Lichtensteinii*. Only a single specimen obtained.

O. Dussumieri, Orb. Pl. 74, figs. 300, 301.

Body elongate, subcylindrical, very finely shagreened with small, acute tubercles; fins short, together rhomboidal; sessile arms unequal, lengths 2, 4, 3, 1; tentacles very slender, clubs not expanded, with thirty hooks in two series. Shell narrow, the apex with a very long, conical, acute, solid tip.

Total length, 20 inches; of body, 6 inches.

200 *miles N. of Mauritius.*

O. rutilus, Gould. Pl. 74, fig. 302.

Body broad in front, narrowed to a point behind; fins large, heart rhomboidal, half as long as the body; head large, subquadrate; sessile arms half as long as body, triquetrous, relative lengths 4, 3, 2, 1; cupules on large pedicels nearly in a single line; tentacles one-third longer than the arms, stout, cylindrical, with nine or ten hooks on long peduncles. Color very brilliant, violet and salmon, with bluish and golden metallic reflections.

Total length, 8·5 inches.

Near Sydney, N. S. Wales.

Allied to *O. Banksii*, but different in proportions and in coloring.

O. BREVIMANUS, Gould. Pl. 74, fig. 303.

Body cylindrical, tapering behind, fins rhomboidal, one-third the length of the body, head short, subglobose; sessile arms short and slender, lower pair longest, and upper pair shortest; tentacles very short, nearly destitute of a club.

Length, 6 inches.

Samoan Islands.

Described from a drawing which is evidently very imperfect, so much so, that but little reliance can be placed on it. It may well be doubted whether this and several following species are specifically distinct from *O. Banksii:* its identity with Mr. Gabb's *O. æquimanus* is very probable.

O. ÆQUIMANUS, Gabb. Pl. 74, figs. 304, 305.

Body fusiform, pointed behind; fins rhomboidal, nearly half the length of the body, outer angle pointed; head small, very slightly subquadrate; sessile arms nearly equal in size, about two-fifths the length of the body, relative lengths 2, 3, 4, 1, the ventral arms connected with the third pair by a small membranous expansion; cupules small and numerous; tentacles more than twice the length of the arms, slender, the club narrow, with numerous rather small claws. Shell narrow, widest near the middle, rounded at upper end, very narrow below and at the point, dilated into a shallow slipper-like termination. Length, 6 inches.

Society Islands.

Described from specimens long preserved in alcohol.

O. FUSIFORMIS, Gabb.

Body slender, fusiform, pointed behind; head small, narrower than the body, subquadrate; arms not half as long as the body, relative lengths 1, 2, 4, 3; tentacles somewhat longer, the clubs but little if at all widened; fins triangular, terminal, half the length of the body. Shell long, very slender, widest in middle.

Length, about 6 inches. Not figured.

"Said to have been caught off Cape Horn." *San Clemente I., Cal.*

O. LOBIPENNIS, Dall.

Body short, inflated, somewhat cup-shaped, rounded behind; fins rounded, ovate on each side, not continuous round the posterior extremity; head rather swollen; sessile arms subequal; tentacular arms somewhat longer, with two hooks in the median line of the clubs between the cupules. Yellowish white, with brown ocellated spots on the back and sides, and brown specks on the arms and head. Total length, 2 inches.

Off San Francisco, Cal.

Not figured. A single specimen obtained, which Mr. Dall doubtfully refers to this genus. No mention is made of hooks on the sessile arms, a character which places *O. Kamtschatica*, Middendorff in the genus *Enoploteuthis*, but in the peculiar arrangement of two hooks, surrounded with suckers on the tentacular clubs, the two species are alike.

O. LONGIMANUS, Steenstrup.

This species is only shortly characterized and not figured, and is referred with doubt to the genus *Onychoteuthis*. It is said to differ from all known forms, by the extraordinary length of the second pair of sessile arms, which are four times the length of the head, and double that of the tentacles.

Genus **ONYCHIA**, Lesueur.

O. CARIBÆA, Lesueur. Pl. 75, figs. 306, 307.

Body oblong, narrowed and prolonged behind; fins round, terminal, together subrhomboidal; arms unequal, order of length 3, 2, 4, 1; tentacles scarcely enlarged at the end. Shell pennate, rather broad, sides rounded. Length, 80 mill.

West Indies.

D'Orbigny and Gray have confounded this species with *O. cardioptera*, the latter being, as Souleyet has pointed out, a true *Loligo*, having no hooks on the tentacles.

O. PERATIPTERA, D'Orb. Pl. 75, figs. 308–310.

Body cylindrical, pointed behind; fins triangular, very wide and narrow; sessile arms long, relative lengths 3, 4, 2, 1; cups very unequal, especially of the lateral arms; tentacles short, not enlarged at the ends. Shell broad, lanceolate, apex with a conical, compressed appendix. Length, 5 inches.

Coast of Chili, Indian Ocean.

Genus **ENOPLOTEUTHIS**, D'Orbigny.

A fossil of the Lithographic stone of the Upper Oxford, from Eichstadt, Bavaria, is referred to this genus; the other species of which are recent.

E. Smithii, Leach. Pl. 75, figs. 311–315.

Head with numerous lines of small tubercles, one series extending up each side of the back of the arms; body smooth above, with seven longitudinal lines of small rounded granules beneath, the lateral lines irregular; sessile arms square, the dorsal pair slightly margined on the outer edge; second pair with a broad, membranous edge; hooks about sixty; tentacles with lower group of ten small cups, half open, rest closed, and ten hooks in two alternating lines. Shell lanceolate, rather broad, outer edge regularly arched. Total length, 8 inches.

W. Africa.

E. unguiculata, Molina.

This is only known through a portion of an immense sessile arm, preserved in the museum of the College of Surgeons, at London. The animal is supposed to have been six feet in length. The cephalic portion, together with parts of the arms of a specimen of great size, referred doubtfully to the same species, have been described and figured by Harting, in Mém. Amsterdam Acad., ix.

South Pacific Ocean.

E. margaritifera, Rüppell. Pl. 75, figs. 316, 317.

Body elongate; fins rhombic, not quite half the length of the body, acute on the sides; eyes with five round tubercles on the ventral side; sessile arms rounded behind, not finned, the third and fourth pairs much thicker; tentacles scarcely clubbed, subulate and unarmed at tip, with a small round group of four or five cups at the base, and three or four small hooks in the middle. Shell broad, lanceolate, thin, transparent.

Length, 2·75 inches, without the tentacles.

Sicily.

Distinguished by its pointed body extending back of the fins, and by the sessile arms having two rows of cups and one of hooks. Two specimens only known.

E. VERANYI, Rüppell. Pl. 76, figs. 318, 319.

Body conical; fins rhombic, half as long as the body, large rhombic on the sides; second pair of arms finned on the outer side; hooks in two series, with suckers at the extremities of the arms; tentacles with three hooks and numerous small suckers.

Mediterranean.

E. OWENII, Verany. Pl. 76, figs. 320–322.

Body conical, pointed behind; fins rhombic, more than half the length of the body, nicked in front, rounded on the sides. Rosy white. Length, about 3 inches.

Mediterranean.

The arms are proportionally longer, and the small cupules of the clubs are more numerous, but this species approaches very closely, and is very likely identical with *E. Veranyi.*

Subgenus **Abralia**, Gray.

Sessile arms with hooks below, and suckers at the tips.

E. ARMATA, Quoy and Gaim. Pl. 76, figs. 323–327.

Body elongate, smooth above, minutely tuberculated underneath, the larger tubercles regularly disposed; head tuberculate; fins triangular, together very broadly lanceolate, terminal; sessile arms slender; third and fourth pairs with two marginal series of small tubercles; second, third and fourth pairs crested externally; tentacles slender, the basal group of three or four cups, hooks four, long, acute. Shell lanceolate, sinuated at the sides near the top. Length, 2·5 inches.

Indian Ocean; Moluccas.

E. MORRISII, Verany. Pl. 77, figs. 328, 329.

Body conical, smooth; head large, sessile, fins very large, occupying two-thirds the length of the body, triangular, together rhomboidal, strongly nicked in front; arms unequal, lower ones much the longest. Shell lanceolate, broad, somewhat sinuated on the sides. Length, 4 inches to end of sessile arms.

Lat., 39° *N.*, *Long.*, 20° *W.*, *N. Atlantic Ocean.*

E. POLYONYX, Troschel. Pl. 77, fig. 332.

Body conically acuminate; fins rhomboidal, rounded at the angle, more than half the length of the body; arms unequal, order of length 3, = 2, 1, = 4, armed with a double series of hooks and suckers at the ends; tentacles somewhat longer, with a double series of suckers and hooks; the outer surface with a single series of distant, small tubercles.

Messina.

Differs from *E. Morrisii* in the relative lengths of the arms.

E. Kamtschatica, Middendorff. Pl. 77, figs. 333–335.

Body conical, pointed behind; fins rhomboidal, long-pointed behind, one-third the length of the body; arms quadrangular, half the length of the body; the lower pair with a quadruple series of suckers only, the upper ones with two rows of hooks and an outer row of suckers on either side; tentacles as long as the body, the clubs thickly covered with suckers, and with two large central hooks. Shell linear, slightly winged, with a moderate central groove, and a small terminal cone.

Length of body and head, 11 inches; of shell, 9·5 inches.

Kurile Isles.

Subgenus **Ancistrocheirus**, Gray.

Fins occupying nearly the whole length of the sides of the back.

E. Lesueurii, Fer. and Orb. Pl. 77, figs. 330, 331.

Body elongated, acuminate behind, with regularly disposed ventral tubercles; fins triangular, occupying nearly the whole length of the sides of the back; sessile arms very large, long, rounded externally, hooks in two indistinct alternate lines, no suckers; tentacles long, moderate, hooks elongated. Shell narrow, lanceolate, with a broad central groove.

Indian Ocean.

Genus **VERANIA**, Krohn.

This name is preferred to the prior one of *Octopodoteuthis*, because the latter is liable to mislead, being very inappropriate for a decapod. Only one species known. The generic character is rather unimportant.

V. Sicula, Rüppell and Krohn. Pl. 77, figs. 336, 337.

Sessile arms rounded externally, third pair rather the longest; fins rounded, about three-fourths the length of the body, continued over the back, with an acute notch behind and a rounded one above. 3 or 4 inches long.

Straits of Messina (very rare).

The tentacles shorter than the sessile arms, and with suckers only on the clubs afford a ready means of identifying this genus and species.

Genus **PLESIOTEUTHIS**, Wagner.

Two species have been discovered in the Solenhofen slate: liassic.

P. PRISCA, Wagner. Pl. 77, fig. 338.

Genus **CELÆNO**, Münster.

Two species from the Liassic formation of Solenhofen are referred to this genus.

C. CONICA, Wagner. Pl. 77, figs. 349, 340.

Genus **DOSIDICUS**, Steenstrup.

D. ESCHRICHTII, Steenstrup.

The type and only species of the genus, its characters are contained in the generic diagnosis. No figure has been published. The locality is rather uncertain: it was at first believed to have been taken at Marseilles, but it is now more probable that it is West Indian. The suddenly reduced arms and their long, narrow ends, puts one in mind of *Octopus filosa*, Howell, from the same locality.

Family X. OMMASTREPHIDÆ.

Genus **OMMASTREPHES**, D'Orbigny.

These animals are gregarious, frequenting the open sea in all climates. Extensively used as bait in the Newfoundland cod-fishery, they are also the principal food of the albatross, the larger petrels, the dolphins and the cachelots. They are called "sea-arrows" or "flying squids" by fishermen, on account of their habit of darting out of the water, often to such a height as to fall on the decks of vessels. The egg-masses are in large clusters, floating on the surface. Pens of four species are found in the Oxford clay, Solenhofen (Liassic), and there is a tertiary species.

Ommastrephes illecebrosa was observed among the wharves at Provincetown, Mass., during the month of July, engaged in capturing and devouring the young mackerel, which were swimming about in schools, and at that time were about four or five inches long. In attacking the mackerel they would suddenly dart backward among the fish, with the velocity of an arrow, and as suddenly turn obliquely to the right or left and seize a fish, which was almost instantly killed by a bite in the back of the neck, with the sharp beaks. The bite was always made in the same place, cutting out a triangular piece of flesh, and was deep enough to penetrate to the spinal cord. The attacks were not always successful, and were sometimes repeated a dozen times before one of these active and wary fishes could be caught. Sometimes, after making several unsuccessful attempts, one of the squids would suddenly drop to the bottom, and, resting upon the sand, change its color to that of the sand so perfectly, as to be almost invisible. In this way it would wait until the fishes came back, and when they were swimming close to or over the ambuscade, the squid, by a sudden dart, would be pretty sure to secure a fish. Ordinarily, when swimming, they were thickly spotted with red and brown, but when darting among the mackerel, they appeared translucent and pale. The mackerel, however, seemed to have learned that the shallow water is the safest for them, and would hug the shore as closely as possible, so that in pursuing them many of the squids became stranded, and perished by hundreds, for when they once touch the shore, they begin to pump water from their siphons with great energy, and this usually forces them farther and farther up the beach. At such times they usually discharge their ink in large quantities. The attacks on the young mackerel were observed mostly at or near high water, for at other times the mackerel were seldom seen, though the squids were seen swimming about at all hours; and these attacks were observed both in the day and evening. But it is probable, from various observations, that this and the other species of squids are partially nocturnal in their habits, or at least are more active in the night than in the day. Those that are caught in the pounds and weirs mostly enter in the night, and evidently when swimming along the shore in schools. They are often found in the morning stranded on the beach in immense numbers, especially when there is a full moon, and it is thought by many of the fishermen that this is because, like many other nocturnal animals, they have the habit of turning toward and gazing at a bright light, and since they swim backwards, they get ashore on the beaches opposite the position of the moon. This habit is also sometimes taken advantage of by the fishermen, who capture them for bait for cod-fish; they go out in dark nights with torches in their boats, and by advancing slowly toward a beach, drive them ashore.—VERRILL.*

* *Body opaque, fleshy, smooth above and below. Cups of sessile arms equal, moderate. Typical.*

† *Second and third pairs of sessile arms without any membranaceous fringe on the inner edge of the ventral side, but replaced by a row of small, conical tubercles.*

‡ *Tentacles with eight rows of numerous small cups near the end of the club.*

O. SAGITTATUS, Lam. Pl. 78. figs. 341. 342, 345; pl. 79. figs. 343. 344. 346.

Head large, body elongate. cylindrical; fins broad, together regularly rhomboidal, nearly half the length of the body; arms thick, long, length 3, 2, 4, 1; tentacles as long as the body, compressed, the club scarcely enlarged, the lower cups in two series, the central in four, the upper in eight series, teeth of the rings obtuse. Shell narrow, elongate, its lateral ribs the largest, the apical cone large. Length, 6 to 12 inches.

Europe; Great Britain to Mediterranean; Newfoundland; New England Coast.

This species is migratory, so that it is sometimes taken in great quantities; it is called Calamaio by the Italian fishermen, and is sold in the markets; but only to the poorer classes, as its flesh, although tender, has an unpleasant taste. The female is shorter and stouter than the male. I figure *O. illecebrosa*, Lesueur (fig. 342), the American representative of this species: it is considered distinct by some naturalists.

* Report U. S. Fish Commissioner for 1873, p. 441–2.

O. CRASSUS, Lafont. Pl. 79, fig. 347.

Body and arms thick; tentacles shorter than the body, the teeth of the small sucker-rings pointed and curved; fins forming an irregular parallelogram, the upper sides of which are shorter than the lower. Shell narrow. Length, 20 to 24 inches.

Bay of Biscay.

Very closely allied to *O. sagittatus*, from which it differs in size, in the form of the fins, and the denticulations of the rings of the suckers.

‡ ‡ *Tentacles with four rows of suckers, those of the middle rows larger.*

O. COINDETII, Verany. Pl. 78. fig. 348; pl. 79, fig. 349; pl. 80, figs. 366, 367.

Body pellucid, cylindrical, slightly fusiform, acuminate to a point posteriorly; fins heart-shaped, about one-fourth the length of the body; arms nearly equal; tentacles a little more than double the length of the arms, and nearly as long as the body, the subulate ends deprived of suckers. Shell narrow, its cone equally narrow. Total length, including tentacles, 5 inches.

Mediterranean.

The shell with narrow cone, the arrangement of suckers on the tentacles, especially the ends being without any, whilst in *O. sagittatus* they have eight rows of them, and the differently shaped fins serve to distinguish this species from the latter, with which it has been confounded. *O. Touchardi*, Souleyet (figs. 366, 367), is probably the young of this species.

O. ÆQUIPODA, Rüppell. Pl. 78, figs. 348–350; pl. 79, fig. 351; pl. 80, figs. 363–365.

Body conical-fusiform, acuminate behind; fins not a quarter the length of the body, short and wide, diamond-shaped; arms, order of length $3 = 4, 1 = 2$; tentacles nearly double the length of the arms, and nearly as long as the body, the clubs covered with tubercles to their pointed ends, of which the middle ones are larger. Shell narrow, with a slight expansion at the cone. Length, including tentacles, 5·6 inches.

Cape Verd Isles; Mediterranean.

Distinguished from *O. Coindetii* by its tentacles, fins and shell.

‡ ‡ ‡ *Tentacles with two series of small suckers at the ends.*

O. TODARUS, Chiaje. Pl. 78, fig. 353; pl. 79, figs. 354–356.

Body short, thick, nearly cylindrical, fins nearly half the length of the body, rhomboidal; arms unequal, rings of their cups with seven very oblique cutting teeth on the higher side; tentacles robust, with scattered suckers nearly their whole length, scarcely clubbed, the suckers of the clubs in two series at base and ends, and four series of larger size in the middle, the rings of these last with twenty acute teeth all round.

Total length, 33 inches.

Southern Europe.

This animal sometimes attains much greater dimensions than the usual length given above. Specimens weighing over thirty pounds are occasionally captured. The flesh is hard, coriaceous and unwholesome, and is but little used, the sale of it being prohibited in the market of Nice. At Genoa it is called Caamà, in Sardinia, Calamari or Todari, in Sicily, Todaru, etc.

† † *Third pair of arms with a narrow fleshy fin, supported by cross ribs on the inner edge of the ventral side; second pair of arms without tubercles on the edge.*

O. GIGAS, D'Orbigny. Pl. 80, figs. 357–360.

Body elongate, cylindrical, violet-colored; fins broad, occupying half the length, nicked in front, together transversely rhomboidal, acute; arms with oblique, equal-sized cups, their rings with acute teeth on the higher side, and smooth on the lower one; tentacles naked one-third their length, the cups in two series, then in four, the tip compressed with a narrow, triangular patch of a few small cups in three or four series at the base, and two series at the end. The shell is very long, its cone proportionally much shorter than in the other species.

Total length, 3·5 feet; length of body, 1·6 feet.

Pacific Ocean, W. of South America. ? S. Clemente Is., Cal.

O. PTEROPUS, Steenstrup.

Animal very like *O. gigas*, and even larger in size; attaining nearly 6 feet in length. The first pair of arms shortest, being a foot long, the others 15 to 16 inches; the tentacles 32 inches.

Mediterranean (Marseilles); Atlantic Ocean.

I have not seen any figure of this species: it may = *O. gigas*, or even include the large specimens of *O. todarus*.

O. Sloanii, Gray.

Body cylindrical, rather tapering behind; fins rhombic, rather more than one-third the length of the body; arms compressed, the third pair acutely finned, with a narrow rayed membrane on the inner edge of the ventral side; tentacles slightly keeled externally, base half naked; cups of lower part small, in two rows, of middle in four rows, the seventh pair of the central series largest (rings with distant teeth all round), of the apical part in three or four rows.

New Zealand; Indian O.

Described from specimens in Mus. Brit., and not figured. The description does not indicate any great difference from the two preceding species.

† † † *Second and third pairs of arms with a broad, membranaceous fin or wing on the inner edge of the ventral side, supported by radiating fleshy rays arising from the base of the cups. Cups in two distinct rows; ventral part of the mantle free from the head.*

O. Bartramii, Lesueur. Pl. 80, figs. 361, 362.

Body elongate, cylindrical, acuminate posteriorly; fins dilated, rhomboidal, the angles acute; head short; arms short, biangulated or triangulated dorsally; tentacles large, short, biangulated. Shell very narrow, the extremity enlarged.

Total length, 10 inches, length of body, 6 inches.

The chromatophores are aggregated into a dark dorsal band.

West Indies; Gulf Stream; Cape of Good Hope?

† † † † *Second and third pairs of arms with a broad membranaceous fin on the inner edge of the ventral side, supported by radiating fleshy rays; cups compressed so as to be generally in a single series.*

O. Oualaniensis, Lesson. Pl. 81, fig. 368.

Body elongated, cylindrical; fins terminal, broad, transverse; arms short, unequal, furnished with one row of cups, tentacles much longer than the arms. Shell elongate, narrow.

Total length about 6 inches.

Indian Ocean; Cape of Good Hope; Pacific Ocean.

O. Tryonii, Gabb. Pl. 81, figs. 372, 373.

Body elongated, cylindrical, tapering to a point behind; fins transversely rhomboidal, between one-third and one-fourth the length of the body; arms short, compressed, robust, comparative lengths 4, 2, 3, 1, nearly equal in length; second and third pairs so compressed that the cups appear in single line; tentacles but little longer than the longest arms, the cupules largest in the middle of the clubs, and becoming smaller towards each end. Total length to end of tentacles, nearly 11 inches; length of body and head, nearly 6·5 inches.

Coast of California.

Very close to the preceding species, from which it may be doubtfully separated by its shorter tentacles.

O. INSIGNIS, Gould. Pl. 81, figs. 369–371.

Body large, subcylindrical, gradually narrowing to a point behind; fins transversely rhomboidal, about one-third the length of the body, the angles acute; arms rather long, ranking 2, 3, 4, 1, nearly equal, the lower pair usually deprived of cupules for about one-third their length from the base, but fimbriated with a double range of compressed, adnate lobules; the cups sometimes compressed into a single series, the lateral pairs have the middle cupules much larger; tentacles one-third longer than the arms, scarcely clubbed, the cupules largest in the middle; the rings of the large cupules with fifteen teeth all round, those of the small ones and of the arms have a half circle of eight teeth. Shell slender, dilated towards each end.

Length, including tentacles, 22·5 inches.

Feejee Isles; Antarctic Seas.

Subgenus **Hyaloteuthis,** Gray.

Body transparent, tubercular beneath; one or two cups on second pair of sessile arms larger.

O. PELAGICUS, Bosc. Pl. 82, fig. 374.

Body elongate, subcylindrical, smooth above, with scattered opaque tubercles in eight cross lines beneath; fins about a quarter the length of the body, very thin, nicked in front, together transverse, rhomboidal, with rounded angles; arms triangular, cups in two alternate lines, long-peduncled; tentacles very slender, scarcely clubbed, with a series of peduncled cups. Diaphanous white, red spotted. Shell very thin, very slender, without ribs, with a small terminal cone.

Total length, 4·5 inches.

Atlantic Ocean; St. Lucia, W. I.

Doubtful recent species.

O. LATICEPS, Owen. Pl. 81, fig. 376; pl. 82, fig. 375.

Body subgelatinous, bluish-white, red and brown spotted, oval, elongate, ending in an acute point; arms equal; tentacles with small cups; fins thin, rounded, terminal. I unite with this species *Cranchia perlucida*, Rang (fig. 375), following Gray; but I see no reason why they should be united, except that they are both very young animals.

Atlantic Ocean, near the Equator.

O. ARABICUS, Ehrenberg.

Body round, gradually attenuating into an obtuse round tail; fins rhomboidal, including half the body and the tail; arms with two rows of equal cups; clubs of tentacles with five rows of cups, three middle rows largest; rings toothed. Shell narrow, cartilaginous.

Volcanic island of Ketumbal, Red Sea.

Not figured; seems peculiar in possessing five rows of cups on the clubs.

O. GRONOVII, Fer. and Orb.

Founded on the *Sepia* of Gronovius Zoophyl. 244, N. 1028, whose short diagnosis will suit any species of *Loligo* or *Ommastrephes* hitherto described or hereafter to be described.

Indian Ocean.

O. BIANCONII, Verany. Pl. 82, fig. 377.

Body cylindrical, tapering behind; fins cordate, depressed, one-half the length of the body; arms short, of nearly equal length; tentacles two-thirds the length of the body. Shell with convex margins, terminating in a small cone; eyes covered with skin. Length, less than an inch.

Messina (abundant).

Evidently a young animal, the generic relations of which are somewhat uncertain. The form of the animal and shell is very like *Onychoteuthis Krohnii*, but it wants the tentacular hooks of that species.

O. AYRESII, Gabb.

Carpenter Report, W. C. Mollusca, 613, 664, 1863. "San Clemente Islands." This species was never described by Mr. Gabb. Perhaps *O. Tryonii*, Gabb is the same species.

[Genus **ARCHITEUTHIS**, Steenstrup.]

A number of gigantic cephalopods allied to *Ommastrephes* or *Loligo* have been described and referred, upon considerations of size principally, to the genera *Architeuthis*, *Megaloteuthis*. *Dinoteuthis*, *Mouchezia*, etc. The three latter names have not been maintained, and are generally allowed to be synonymous with the first or with *Ommastrephes*. With regard to *Architeuthis*, it is said to be insufficiently characterized in a proof copy with plates, of a paper entitled "Spolia Atlantica," and intended to be published in the Memoirs of the Copenhagen Academy, 5th ser., vol. iv, 1856. I have examined this journal, but do not find the paper included in it, and therefore suppose that the publication was suppressed. So vague have been the views regarding this genus among those who have described the species, that each one has a different idea of its characters. Mr. A. E. Verrill, who has more carefully studied these immense cephalopods than any of his contemporaries, has himself been mislead into describing and figuring a portion of the mouth lining for the tongue (see pl. 6, fig. 6), but afterwards discovered his mistake by finding the real odontophore, which has the essential characters of *Ommastrephes*. It is quite probable that some of the vague characters given in the descriptions of these immense animals are sexual or only individual, and that future investigation will reduce the number of species. I prefer for the present to treat them all as a section of *Ommastrephes*, and will here enumerate the distinctive characters as far as ascertained: the popular descriptions of them may be found in the first part of this work (p. 74, *et seq.*).

O. ROBUSTUS, Dall.

Three specimens discovered on the coast of Alaska, by Mr. W. H. Dall, in 1872. He preserved portions of one of them. The largest specimen had a total length of 14 feet, but the ends of the tentacles had been destroyed; length from tail to root of arms, 102 inches; to front edge of mantle, 91·5 inches; width across fins, 42 inches; diameter of body, 18 inches; slender portion of tentacular arms remaining, 61 inches; diameter, 2·5 inches; shorter arms (ends and suckers gone), 30 to 40 inches; diameter of eyes, 1·25 inches; length of pen, 89 inches.

The eyes were furnished with lids. The few suckers remaining on some of the shorter arms of one specimen, were alternate in two rows, and agree with those of *Ommastrephes*. The color was reddish, in fine red dots on a white ground, a darker stripe on the outer median line of the arms. Tail acutely pointed.

Alaska.

O. Bouyeri, Crosse and Fischer.

O. Hartingii, Verrill.

These may prove to belong to *Ommastrephes* instead of *Loligo*, under which genus they are described (p. 149).

O. Mouchezi, Vélain. Pl. 82, fig. 378.

The animal, stranded upon the volcanic island of St. Paul, in the Indian Ocean, was photographed as it lay; and an engraving made from the photograph, together with the beaks, pharynx and a tentacle brought to Paris, are the basis of a short and unsatisfactory account of it. The truncated arms and the gradually attenuating body, with very narrow fins extending along each side for half its length, are noticeable peculiarities, as is also the web connecting the arms; it is questionable, however, how much the engraving may be relied upon. It has received a generic name, but may be preferably retained in *Ommastrephes* for the present.

O. (Architeuthis) monachus, Steenstrup. Pl. 83, fig. 379; pl. 84, figs. 380–385.

Body stout, cylindrical, attenuated to the end; with arrow-shaped fins, comparatively small; arms rather long, sub-equal, the suckers in two rows, with rings sharply denticulated all around; tentacles remarkable for their great length, being each 24 feet long, but only 2·75 inches in circumference, the club is 30 inches long, with minute suckers with entire or slightly toothed rings, interspersed with tubercles on the lower part (the tubercles probably intended for the adhesion of the suckers of the opposite tentacle, as a *point d'appui*); the middle portion has two rows of large suckers and an outer row of smaller ones on either side; the tip of the club is covered with four rows of small suckers.

Length of body, 7 feet; circumference, 5·5 feet; tail, 22 inches across; arms, 6 feet long, their suckers 1 inch in diameter; upper jaw nearly 4 inches, lower one 3 inches long.

Portions of the pen were preserved, as well as the odontophore; they seem to agree with *Ommastrephes.*

The above dimensions and the figures which we give, are from a specimen captured November, 1873, at Logie Bay, Newfoundland.

Dinoteuthis proboscideus, More (of which we have given a detailed account on p. 79), stranded on the Irish coast two hundred years ago, belongs to this species; the power of projecting the beak like a proboscis, which furnishes the generic character, is common to several genera, if not all of the decapods. Another specimen taken recently off Boffin Island, W. coast of Ireland, is also referred to *A. monachus* by Mr. Verrill, although supposed by Mr. More to = *A. dux.*

O. (ARCHITEUTHIS) PRINCEPS, Verrill. Pl. 85, figs. 386, 387.

This species is based on some jaws, and on rough measurements of the remains of specimens not preserved. A pair of jaws obtained from the stomach of a sperm whale, are figured, and show a close resemblance to *A. monachus.* They are larger, the length of the upper jaw being 5 inches, and somewhat different in shape and proportions from that species. The texture of these beaks is firmer, and the lamina are relatively thicker than in *A. monachus.* The rostrum and most of the frontal regions are black and polished, gradually becoming orange colored and translucent towards the posterior border. It is believed to be the largest described species, measuring 40 feet from tail to tentacular extremities.

Newfoundland.

A living specimen was cast ashore (Sept. 24th, 1877), during a severe gale, at Catalina, Trinity Bay, N. F. After death, it was packed in brine and forwarded to the New York Aquarium, where Mr. Verrill had the opportunity of examining it. It measures 9·5 feet from tip of tail to base of arms; circumference of body, 7 feet; length of tentacular arms, 30 feet; of longest sessile arms (ventral ones), 11 feet; circumference at base, 17 inches; length of upper mandible, 5·25 in.; diameter of large suckers, 1 inch; of eye sockets, 8 inches. The eyes were destroyed by the captors, but were replaced by a taxidermist, who has inserted two large, round, red eyes, close together on the top of the head! It agrees in general appearance with *A. monachus*, but the caudal fin is broader and less acutely pointed; it was 2 feet, 9 inches broad, when fresh, and broadly sagittate in form. The rims of the large suckers are white, with very acutely serrate margins, and the small, smooth rimmed suckers, with their accompanying tubercles, are distantly scattered along most of the face of the tentacular arms, the last ones noticed being 19 feet from the tips. The sessile arms present considerable disparity in length and size, the dorsal ones being somewhat shorter and smaller than the others; the serrations are smaller on the inner edge than on the outer of the suckers.

A. TITAN, Steenstrup. Pl. 86, fig. 388.

This is founded on an animal obtained in 1855, by Captain Hygom, in N. lat. 31°; W. long. 76°. It is one of the species contained in a proof sheet of a paper intended to be published in the Memoirs of the Copenhagen Academy, but which, for some unknown reason, does not appear to have been issued. Steenstrup furnished to Harting a drawing of the lower jaw of this species, which the latter has published under the name of *A. dux*, Steenstrup. A pen six feet long, and other important portions of this specimen were secured. The lower jaw is a little larger than that of *A. monachus*, which it resembles; but it is more rounded dorsally, less acute, and scarcely incurved, the notch is narrow, and the alar tooth is not prominent.

A. DUX, Steenstrup.

As stated above, the only accessible figure of *A. Titan* is that of a jaw published by Harting, under the name of *A. dux*. I am not able to state whether this is an error of Harting's, or whether Steenstrup has used two names for the same species or specimen. Steenstrup (in his "Spolia") mentions having the arm-hooks, and if these animals really had hooks, they will go into the family Onychoteuthidæ instead of Ommastrephidæ. *A. dux* of most writers, however, = *A. monachus*, as shown by Prof. Verrill.

A. MEGAPTERA, Verrill.

Much smaller than the previously known species, the total length of the body and head being but 19 inches. Body relatively short and thick. Caudal fin more than twice as broad as long, the length about half that of the body; nearly rhombic, ventral anterior edge of mantle concave centrally to a slight angle, from which it is again concave to the sides; dorsal anterior margin produced into a prominent obtuse central angle. Eye sockets large, oblong, with distinct lid-like margins; eyes large, oblong, naked. Short arms triquetral, upper ones somewhat shorter and smaller than the others, which are nearly equal in length, the second pair being the stoutest and a little longer. Tentacles slender, elongated, expanded toward the tip, with suckers much as in the gigantic species, even to the smooth edged suckers and opposing tubercles, proximal to the larger suckers, as in *A. monachus*. The sucker-bearing portion is margined by a membrane on each side. Large suckers of sessile arms very oblique, with the rim strong, dark brown, with large, strong, sharp, much incurved, unequal teeth on the outer side of the rim; inner margin entire. On the middle or larger suckers of the ventral arms, there are seven large teeth, the middle one longest, while on either side there is one nearly as large, with a smaller one each side of it.

Total length, 43 inches; length of tentacles, 22 and 24 inches; of arms 1, 6·5 inches; 2 and 4, 8 inches; 3, 8·5 inches.

Cape Sable, Nova Scotia.

A single specimen cast ashore several years since. The above description made from it as preserved in alcohol in the Provincial Museum, at Halifax. For the present it must be considered a doubtful species.

Family XI. SEPIIDÆ.

Genus SEPIA, Linn.

This genus is world-wide in its distribution, and includes also ten fossil species from the Oxford Clay, Solenhofen, and a single fossil species from Texas. Of the thirty recent species, one-third are known by the shell only, and in the arrangement which follows, these are necessarily placed in accordance with their resemblance to the shells of those species of which the animal is known. Steenstrup believes that the species, being exclusively littoral, have not any extended geographical distribution, and therefore probably many undescribed species exist; at the same time he carefully warns naturalists not to confound the considerable differences which are really individual only with those of specific importance—advice which is equally pertinent to the cephalopods in general.

Dr. J. E. Gray thus groups the shells of the Sepiæ with reference to the figures in Ferussac and d'Orbigny's monograph:—

* Shell oblong.
  † Apex very blunt. S. OFFICINALIS, S. LATIMANUS.
  † † Apex produced. S. VERMICULATA, S. ROUXII, S. RAPPIANA, S. BERTHELOTI, S. HIERREDDA, S. ACULEATA, S. BLAINVILLII, S. ROSTRATA.
  † † † Apex very blunt and produced. S. TUBERCULATA, S. PAPILLATA, S. MAMILLATA, S. LEFEBREI.

* * Shell oblong, produced behind. S. INERMIS, S. SINENSIS, S. ORNATA, S. MICROCHEIRUS.

* * * Shell very narrow behind, and arched.
  † Apex simple. S. AUSTRALIS, S. RUPELLARIA, S. CAPENSIS, S. ORBIGNYANA.
  † † Apex dilated. S. ELEGANS, S. ELONGATA.

The above grouping may serve to approximately determine the species of the Sepiostaires, but it does not correspond with the external relationships of the animals, as shown by Dr. Gray's synopsis, which is herein adopted.

§ *Sessile arms with small equal cups, all in four regular series.*

* *Tentacles with five or six series of unequal-sized cups.*

S. OFFICINALIS, Linn. Pl. 86, figs. 390, 391; pl. 87, fig. 389.

Body ovate, depressed, smooth; head with two elongated, and some smaller beards above; arms short, strong, unequal, order of length 4, 3, 2, 1, ring of cups smooth, entire; clubs of tentacles much enlarged, with six alternating lines of cups, the five central cups much larger, rings of the larger cups smooth, of the smaller ones toothed. Black purple, with darker cross bands, forked, and with small white spots on the side. Shell oblong, broadly lanceolate without the cartilaginous fringe, white except on the back, which is faintly tinted with flesh color; back hard, closely corrugated, with an indistinct central ridge and a slight diverging furrow on either side of it; excavated posterior portion of the lower side (that showing the successive transverse growth layers) less than half the length of the shell, so that the highest part of the ventral surface is posterior to the middle of the total length of the shell.

Length, 6 to 8 inches. When irritated, the skin of the animal becomes tuberculate.

European Seas.

According to Verany, this animal prefers rocky localities, where it is fished by means of a dredge called a balancelle, and is also taken at night with the trident. During the month of March the fishermen use a living female Cuttle fastened to a rope, or an imitation of one formed of wood and made attractive to the male sex by being ornamented by bits of glass: this latter enveiglement is called by the Sicilians a Fumedda, and fishing with either of them is very productive and amusing, especially on a moonlight night. These animals may weigh several pounds; their flesh is much esteemed and abounds in the Italian markets at all seasons of the year. Out of the water the Sepia dies quickly, with violent efforts. At Rome the pigment Sepia is still manufactured from the ink of this animal. The chalky thickening of the shell is used as a dentifrice,* and also for modeling metallic objects, its surface receiving an exceedingly accurate impression.

The body of the male is always more oval than that of the female, and its fins are distinguished by a white line of border.

Sepia officinalis (says Aucapitaine) is esteemed everywhere (in Algiers) as food, and is savory as well as sufficiently delicate. It would be as easy as useful to multiply these cephalopods in the oyster-parcs established on our coasts. A great quantity of the eggs of this mollusk are the prey of crustaceans, and the scarcely hatched young are gathered by fishermen for bait. I have seen thousands of these young sepias carried to the Algerian market, which, two or three months later would have had a value of 5 to 15 centimes each. They would be a useful

* This manufacture is extensively pursued in Liverpool; as much as 12 cwt. of cuttle-bone arriving at one time for this purpose.

supplement and change of food for the people, and one more resource for the sea-coast population; for which reason they are recommended to the attention of pisciculturists. In a single rosette of eggs, I have counted more than a thousand embryos.*

S. Fillιouxιι, Lafont. Pl. 86, fig. 392; pl. 87, fig. 393.

This is a larger animal than *S. officinalis*, reaching a length of 14 inches. It is distinguished by its shell, which is proportionally shorter and broader, especially towards the base, much flatter on the under side, the excavated portion (that showing the striæ) extending over two-thirds of that face, with the layers more remote; the cartilaginous hood is larger and deeper, and the spike is smaller and less conspicuous; the granulations of the superior face very large.

Mediterranean; Northern and Western Coasts of France.

This species has been confounded with *S. officinalis* by most naturalists, from which it may be distinguished externally by its larger size, more reddish tint (that of *S. officinalis* has a greenish tendency) and longer arms. The eggs are very large (10 to 12 mill.), elongated and very numerous. Lafont states that the males of these two species are continually at warfare, and that he has seen the *S. Fillιouxii* devour small specimens of *S. officinalis.*

S. Fischeri, Lafont.

Animal not exceeding 8 inches in size. Shell thin, much less thickened than either of the preceding species, the striæ of the lower face commencing close to the anterior end (covering nearly the whole face), much higher than *S. Fillιouxii*, especially in the females; granulations of the superior surface large, but less detached than in the preceding species.

This species deposits its eggs later than the others, as observed by Mr. Lafont. The shell of the male is sensibly narrower than that of *S. Fillιouxii*, and approaches the form of that of *S. officinalis:* that of the female is, on the contrary, wider than in either *S. Fillιouxii* or *S. officinalis*, is much more

* Rev. et Mag. de Zool., 369, 1862.

concave, more enlarged behind and acuminated in front; its want of thickness gives it an entirely peculiar appearance. The eggs are small, not exceeding 8 mill. diameter.

France; Bay of Biscay; Mediterranean.

This species has not been figured.

S. Rouxii, D'Orb. Pl. 87, figs. 394–397.

Body smooth, ovate, rounded posteriorly; fins broad; head smooth, buccal membrane with five prominent lobes; arms elongate, unequal, order of length 4, 3, 2, 1, the rings of the cups with long, acute teeth on their border side; tentacles with six rows of cups, the two middle rows composed of seven very large cups, the rings armed all round with short teeth. Shell ovate, oblong, wrinkled and tuberculated, thickened underneath posteriorly, with a short blunt beak, and a very thick convex diaphragm occupies all the extremity of the cavity.

Length, 25 inches.

Red Sea; Indian Ocean.

S. Vicellius, Gray.

Blackish, smooth; arms thick, the lower rather larger, cups rather large, with entire rings; tentacles moderate, slightly finned, the cups smaller than those of the sessile arms, in five rows, five or six of those in the central line about treble the size, with dark rings very minutely and bluntly toothed on the edge. Shell oblong, rather attenuated above, dilated behind; apex blunt, not produced beyond the horny part at its base; back rugose, subconcentric.

Habitat unknown.

Described from a specimen in Mus. Brit., and not figured.

S. Hierredda, Rang. Pl. 88, figs. 398, 399.

Body ovate, depressed, rather tuberculate; fins broad; head with a beard on each eye; ear with a longitudinal and transverse ridge; arms thick, unequal, order of length 4, 3, 1, 2, rings of cups with small teeth all round; tentacles with very unequal cups in six rows, the middle ones being very large, and the rings entire. Brown and yellow marbled, with indefinite white spots and a series of six white lines on the sides. Shell ovate, compressed, acuminated anteriorly, rounded posteriorly, with a long curved beak; the ventral striæ extending to half the length. Length, 25 inches.

Atlantic and Algerian Coasts of Africa; Teneriffe; Cape.

In its proportions, both of animal and shell, this species is very similar to the preceding, but differs in the dentition of the rings of the suckers, and in the number of tentacular rows.

S. LATIMANUS, Quoy and Gaim. Pl. 88, figs. 400, 401.

Body ovate, smooth, truncated in front, pointed behind; fins narrow, blue-edged; arms slender, quadrangular, elongate, unequal, order of length 4, 3, 2, 1, the rings of the cups with very fine, close teeth; tentacles dilated, strongly palmated, having five rows of cups, of which six or eight are very large, with their horny rings plaited on the edge. Shell oblong, rounded anteriorly, obtuse posteriorly, longly and acutely beaked.

Length, 16 inches.

Indian Ocean; New Guinea; Celebes.

S. TUBERCULATA, Lam. Pl. 88, figs. 403, 404; pl. 89, figs. 402, 405.

Body ovate, tuberculated, the tubercles very unequal, divided into lobes; fins narrow; head tuberculated on the back, sides, and round the eyes, smooth below; arms short, thick, unequal, length 4, 3, 2, 1, the extremities of the arms with eight rows of very small suckers, rest with four rows; tentacles very long, thickly clubbed, with five rows of cups, four cups very much larger, with oblique, entire rings. Shell much depressed, ovate, equally rounded at each end; above smooth, and cartilaginous on the sides and ends; beneath very concave. Length, 20 inches.

Cape of Good Hope.

S. VERMICULATA, Quoy and Gaim. Pl. 89, figs. 406, 407.

Body ovate, smooth, acute anteriorly; fins broad, largely separated behind, dotted with red; head large; arms short, thick at base, unequal, length 4, 3, 2, 1, the cups with entire rings; tentacles very long, cylindrical, club flattened, with very numerous cups, eight or ten larger than the rest with entire rings. Shell oblong, ovate, bluntly beaked posteriorly.

Length, 15 inches.

Cape of Good Hope.


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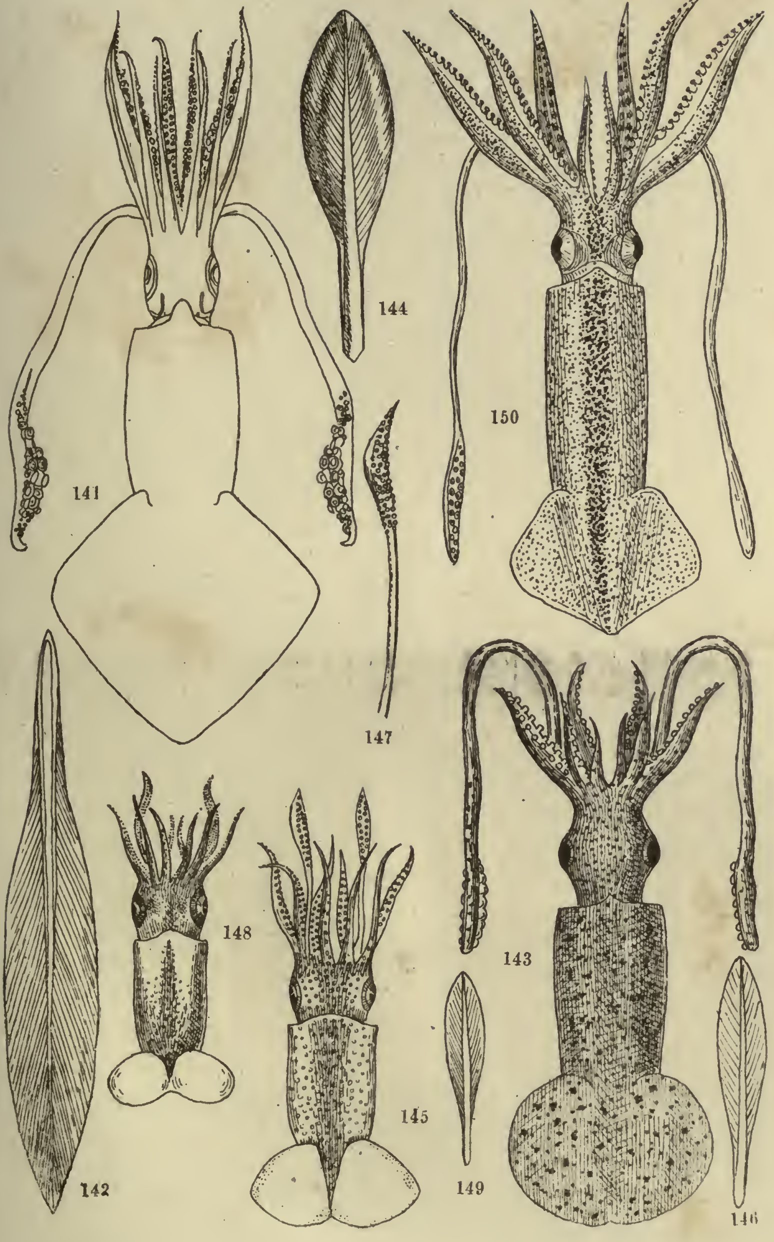
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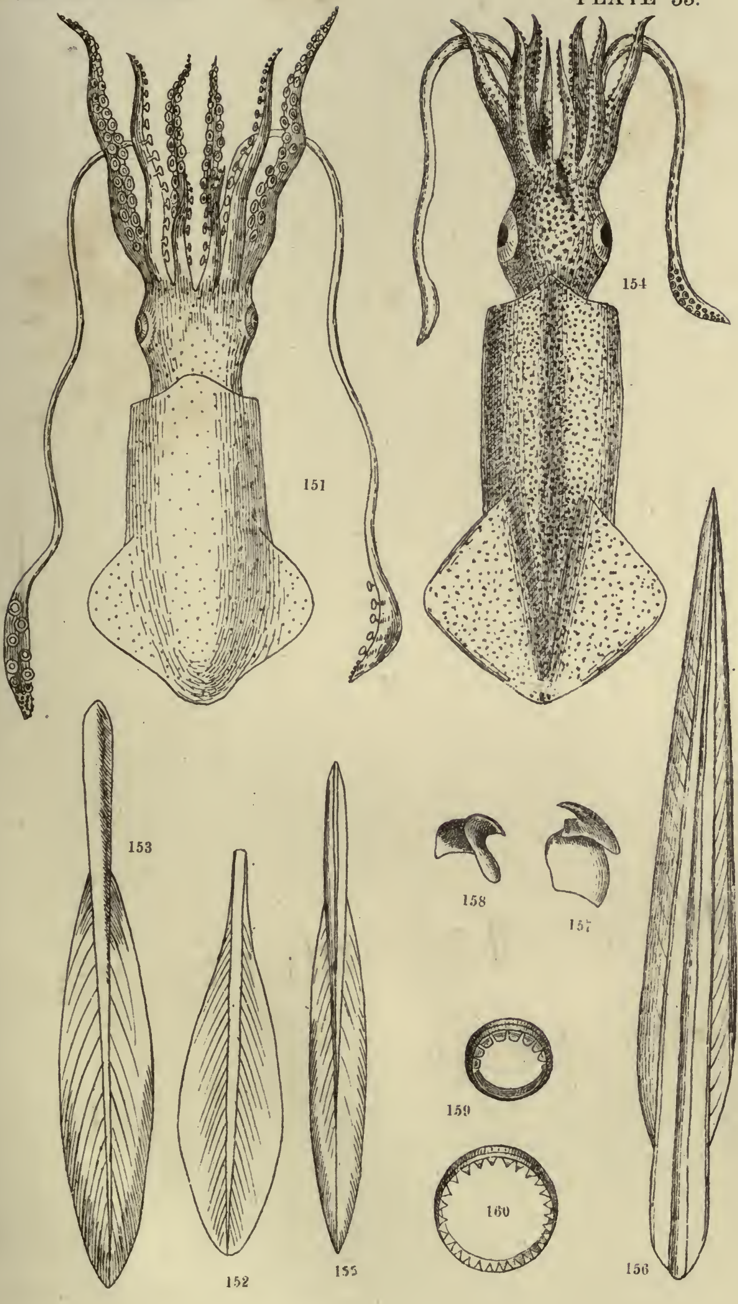
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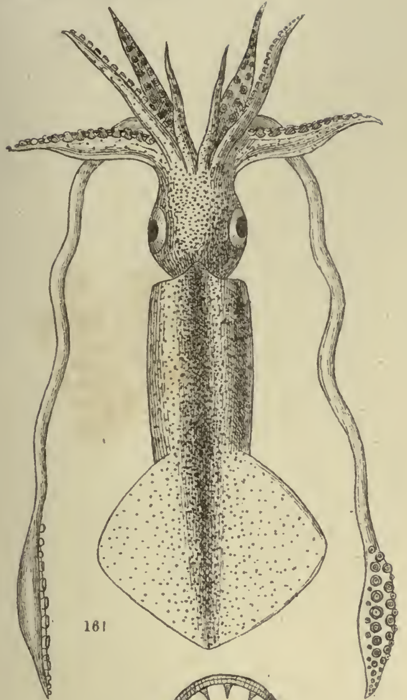

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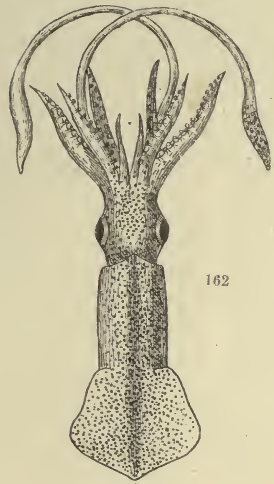

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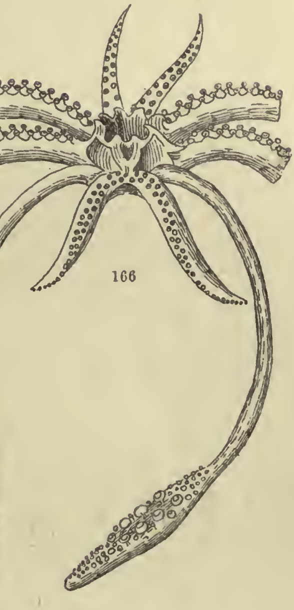

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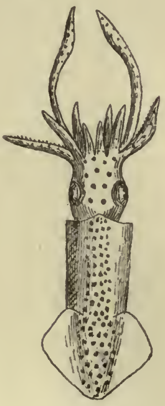

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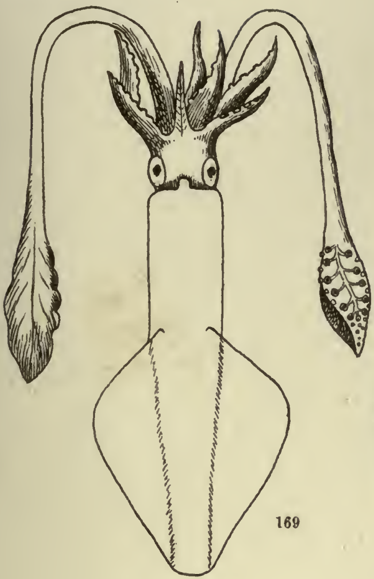

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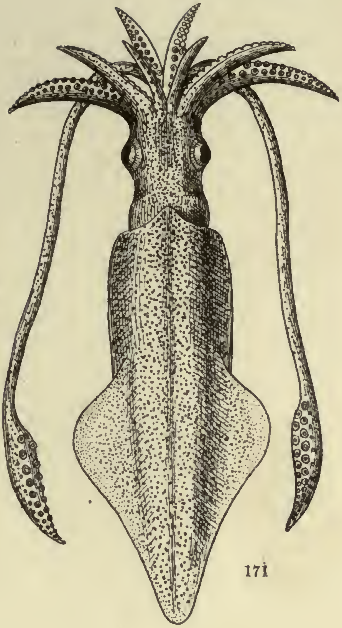

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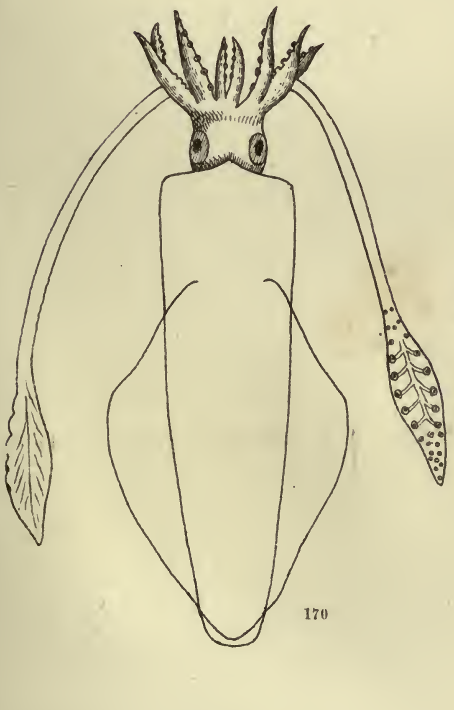

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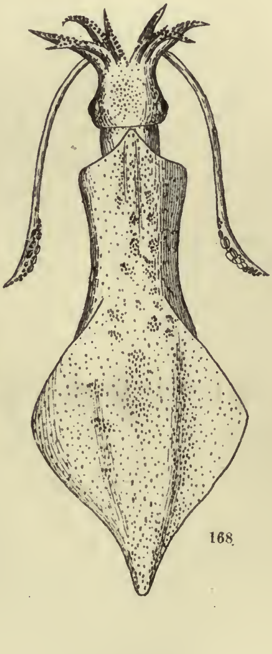

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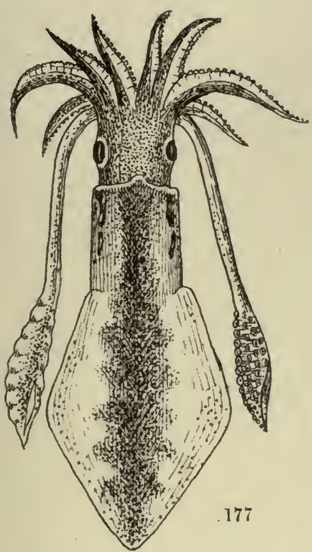

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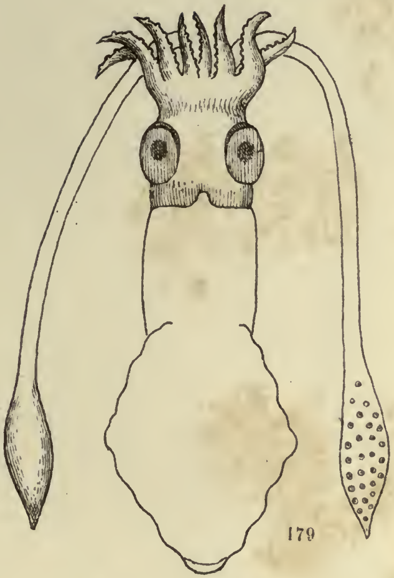

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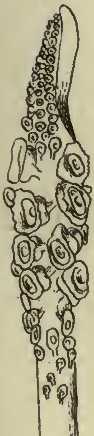

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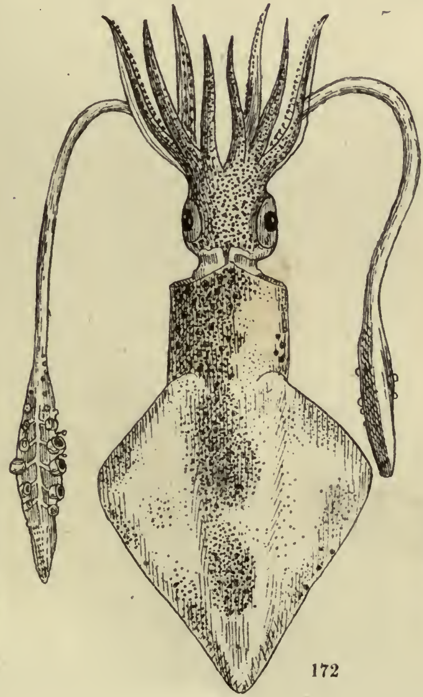

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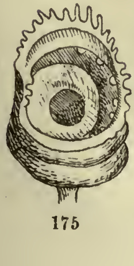

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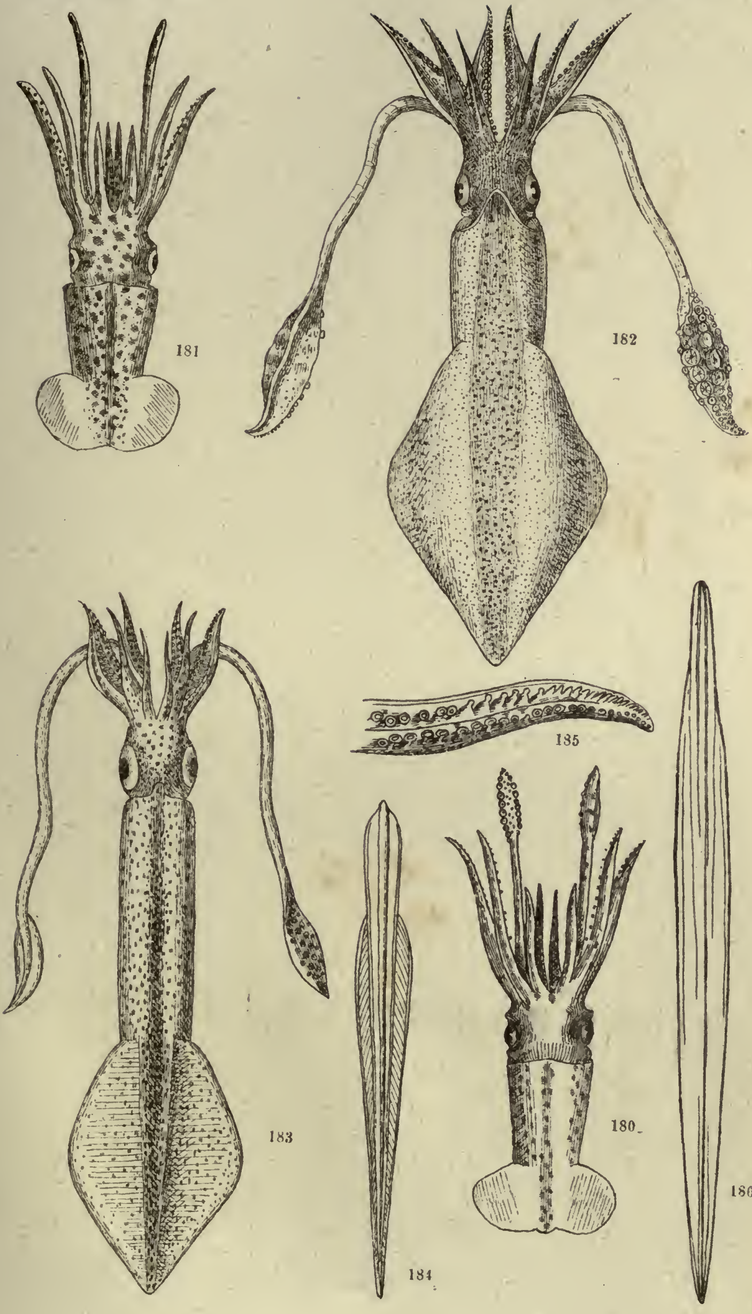
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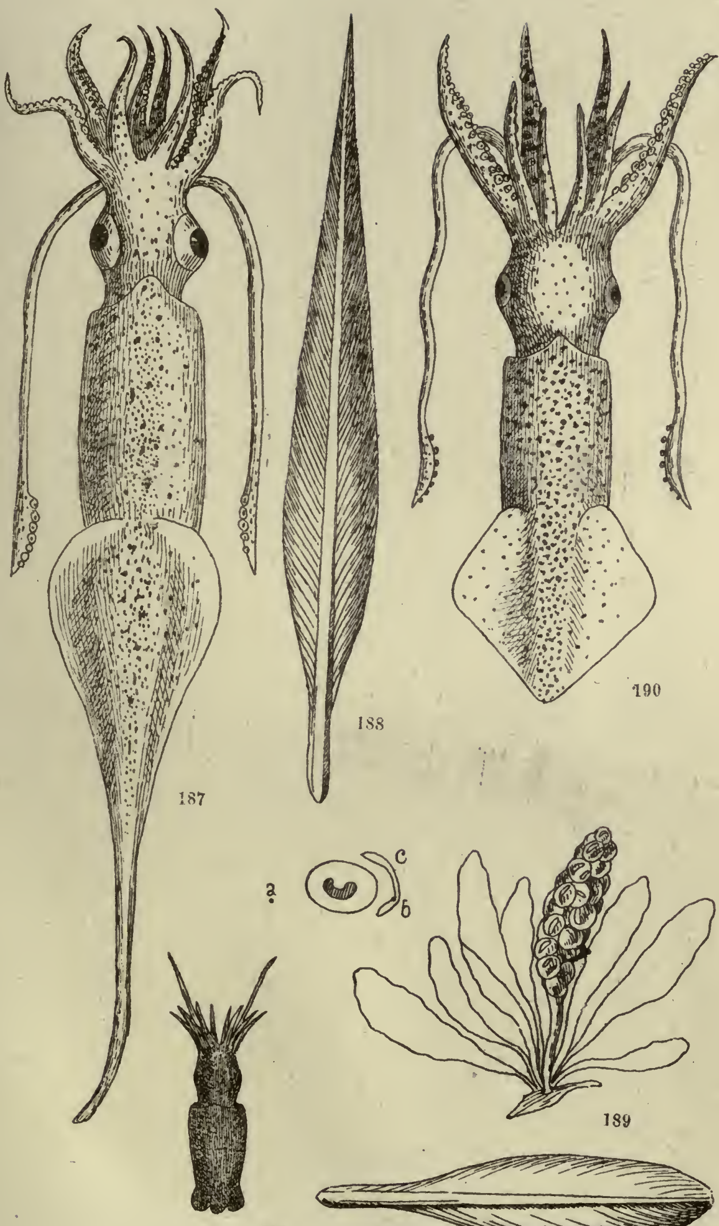

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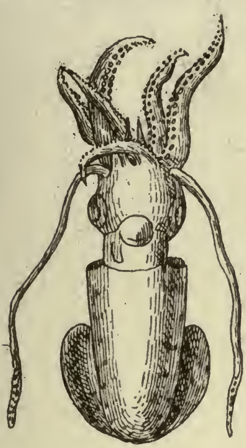

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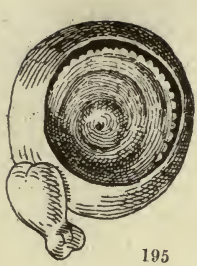

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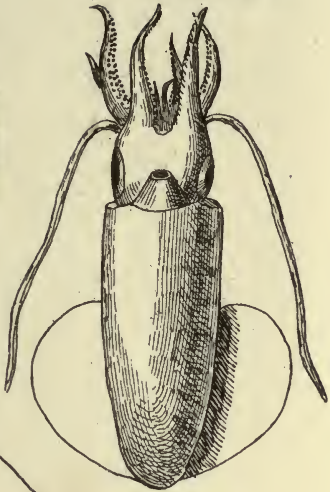

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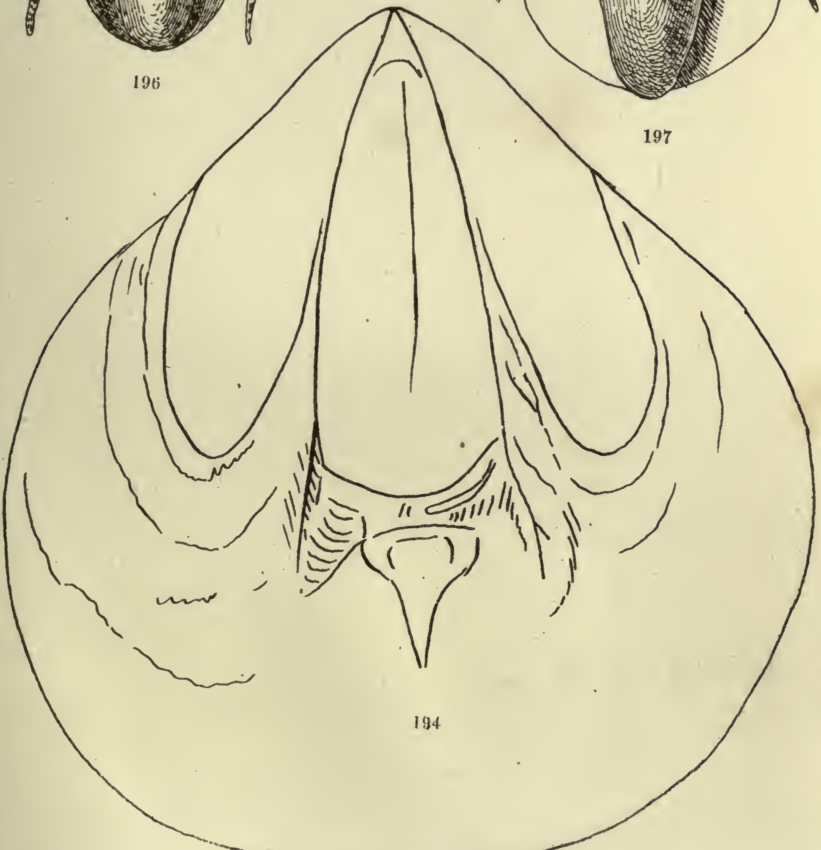

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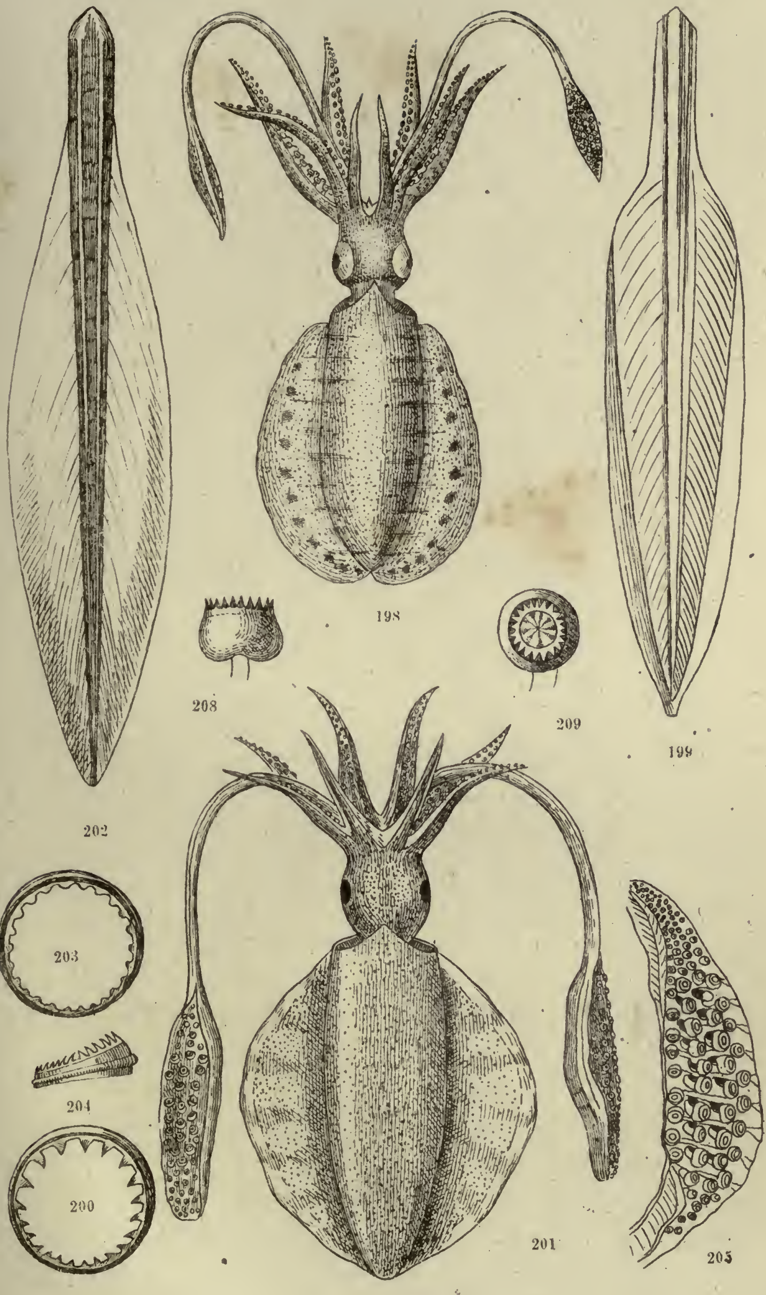
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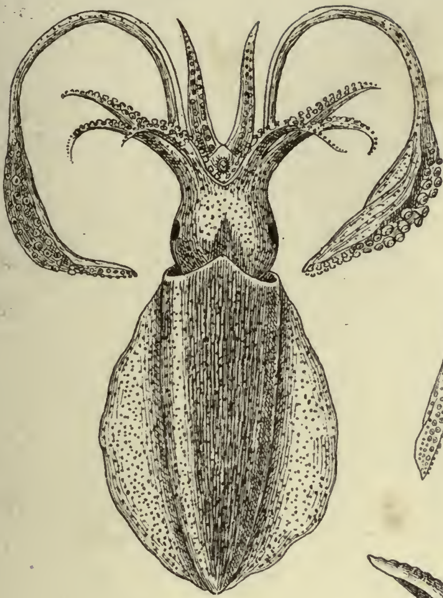

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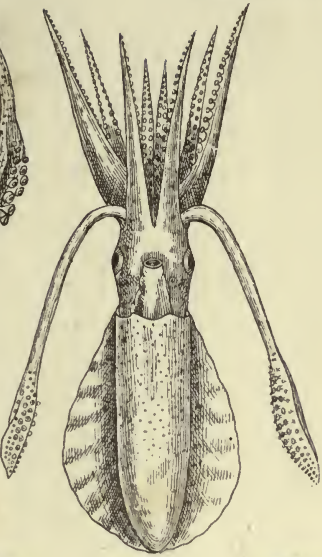

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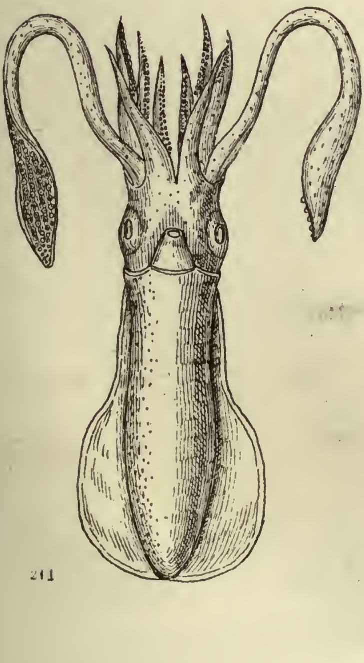

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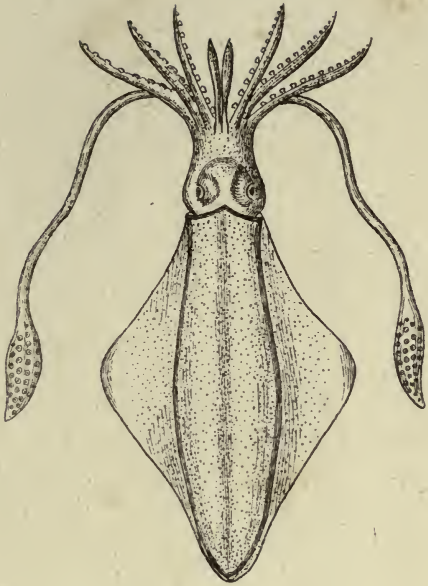

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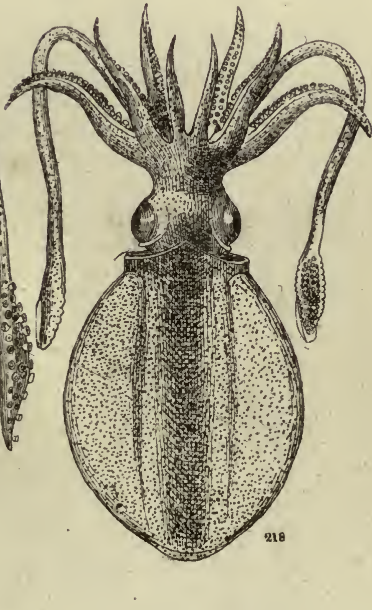

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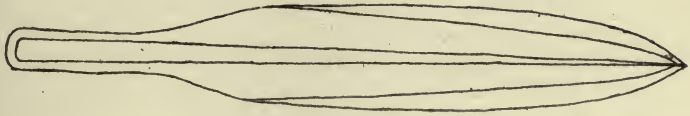

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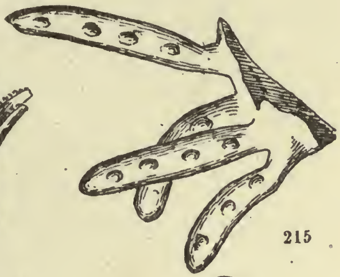

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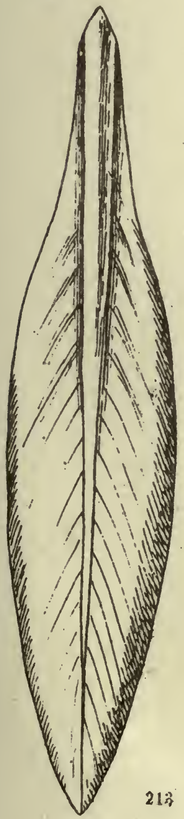

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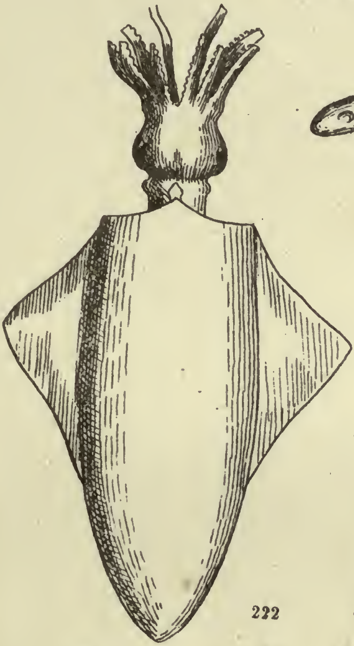

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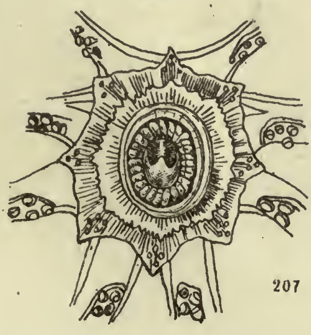

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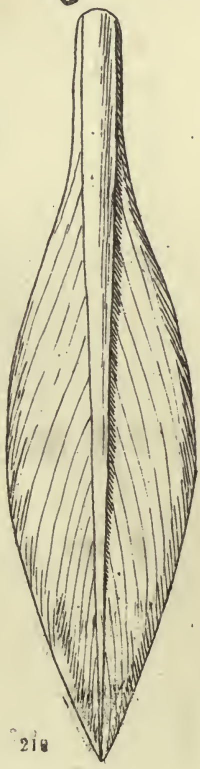

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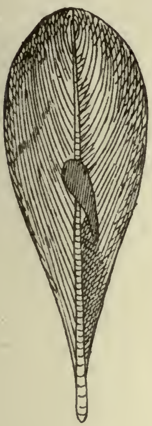

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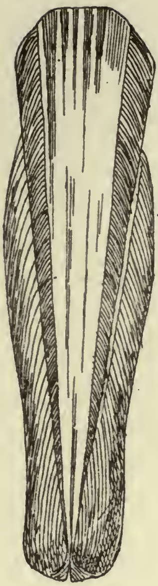

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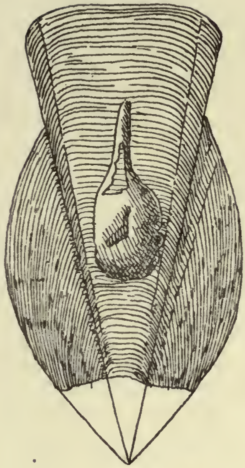

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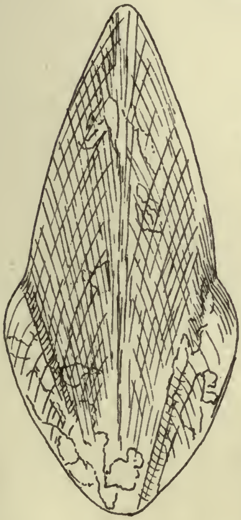

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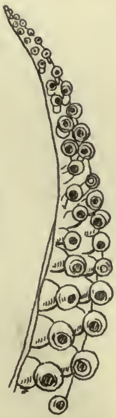

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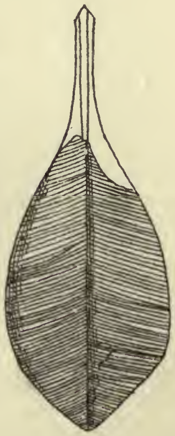

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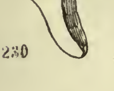

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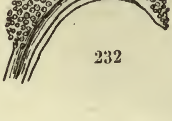

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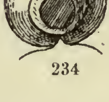

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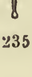

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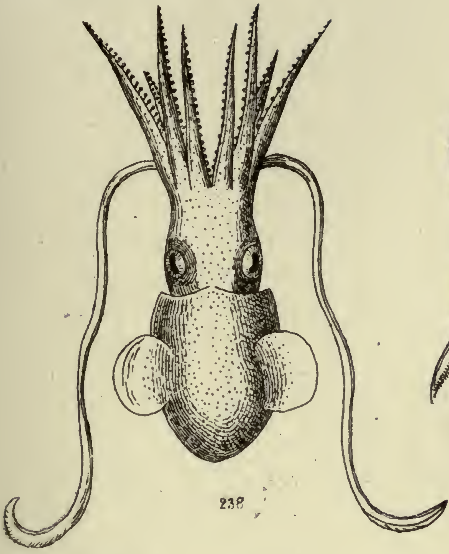

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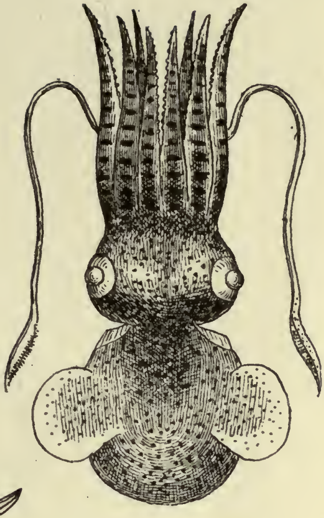

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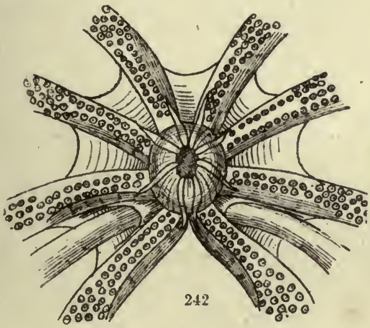

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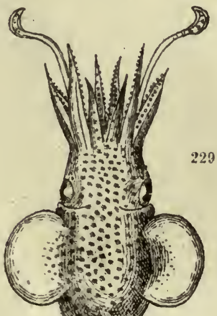

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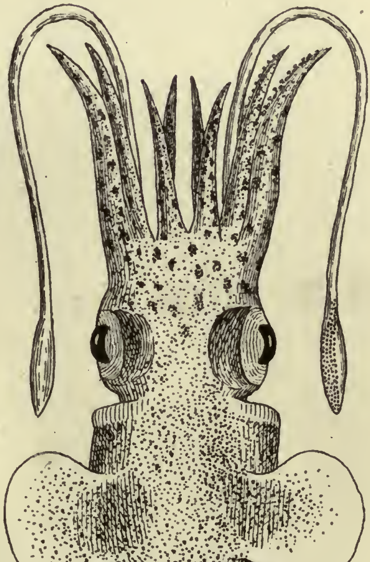

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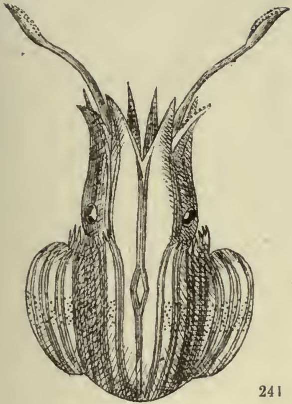

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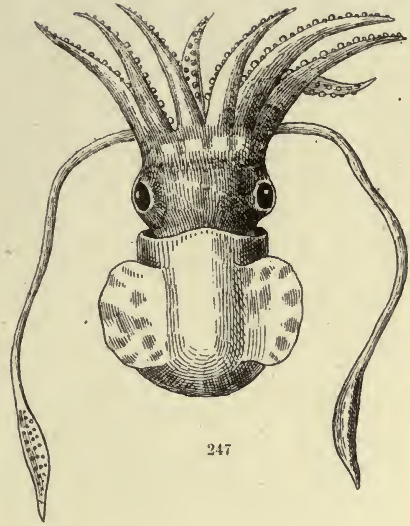

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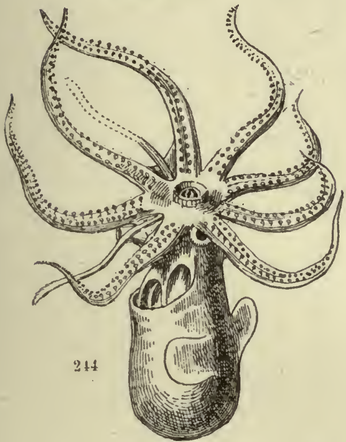

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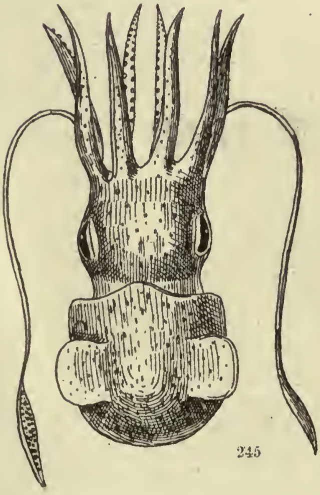

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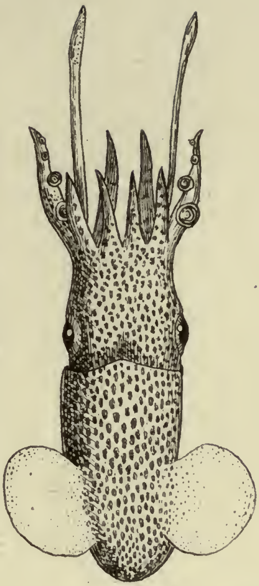

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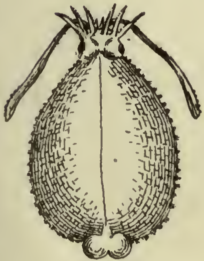

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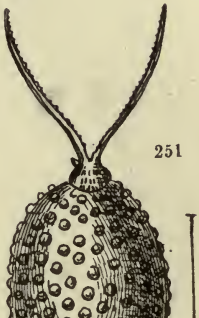

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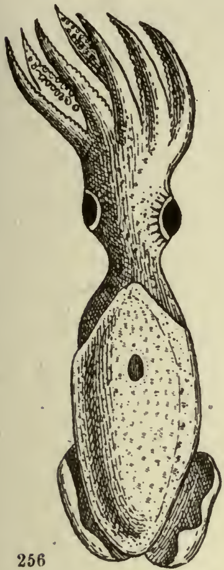

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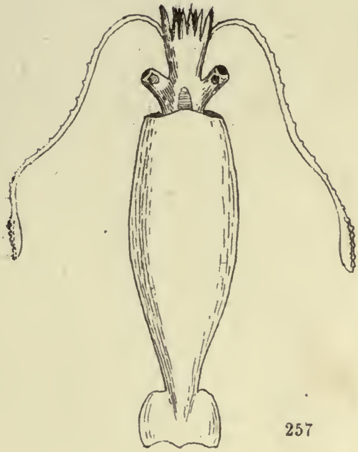

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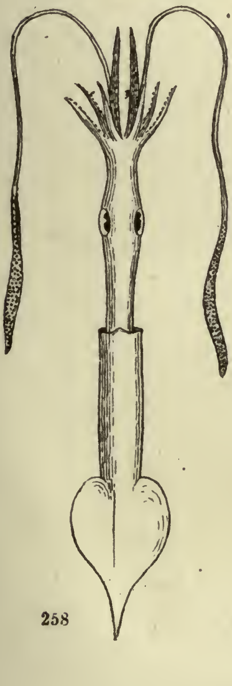

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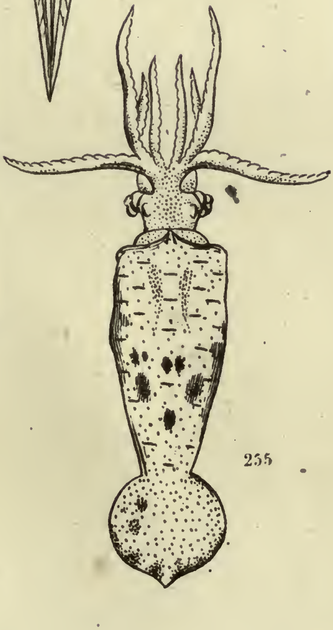

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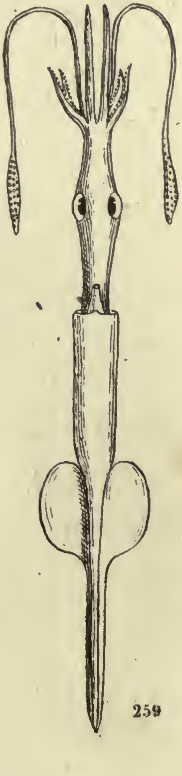

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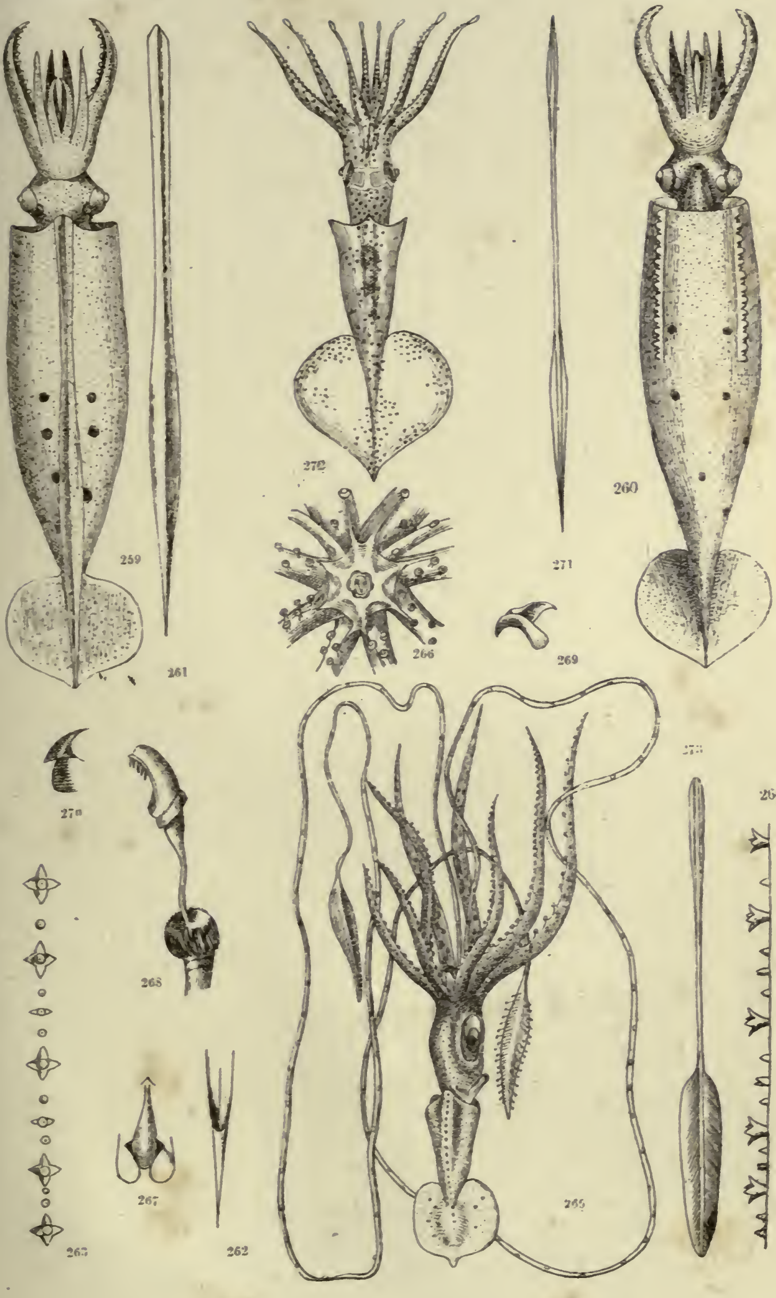
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D'Orbigny suggests that this may = *S. hierredda*, Rang; it certainly resembles it, particularly the shell; but there is a still greater external resemblance to *S. tuberculata*, although the shells are different. The tubercles of the latter may be due to irritation only, and the differences of cups and shell are possibly only sexual.

S. Andreana, Steenstrup. Pl. 89, fig. 408; pl. 90, figs. 409, 410.

Body long, pointed behind; fins narrow; second pair of arms nearly double the length of the others, and their extremities with the cups in two series instead of four; tentacles rather short, cylindrical, with thick, short clubs and five rows of suckers, four in the middle row being much larger. Shell narrow, elongated, with a recurved rostrum.

Japan.

Not unlike *S. Bertheloti* in general appearance, but differs from all other species in the great length of the second pair of arms; the shell resembles no other in this section of the genus, its nearest relation being *S. elongata.*

** * Cups of tentacular arms in five or six series, sub-equal, moderate sized.*

† Shell oblong.

S. Lycidas, Gray.

Sessile arms with four series of rather large equal cups; tentacles elongate, the club distinct, slightly finned behind, with five series of cups: those of the middle equal sized, nearly the size of those on the sessile arms; of the lower and upper end smaller. Shell oblong, rather elongate, slightly produced above, narrowed, produced and rounded behind; apex blunt, cavity with a strong, raised, rounded ridge on each side behind; disk convex, with a broad central concavity extending nearly the whole length.

China.

Described from a specimen in Brit. Mus. obtained salted in the market of Canton.

† † Shell elongate, narrow.

S. Bertheloti, Fer. and Orb. Pl. 90, figs. 411, 412.

Body oblong, elongated, subcylindrical, smooth, blunt behind and pointed in front; fins narrow, broader behind; ears simple;

arms long, slender, unequal, order of length 4, 2, 1, 3; tentacles long, slender, the cups in five rows, central row largest with oblique rings toothed all around. Purplish, with oblong pale spots on the sides. Shell elongate, very narrow, finely wrinkled above, acuminated in front, and with a long, acute beak, and wings on the side behind. Total length, 1 foot.

Teneriffe.

S. PLANGON, Gray.

Body oblong; fins narrow, pale; back of mantle much produced in front; arms rather thick, with the cups small and distant; tentacles slightly clavate, with a few very small, sub-equal cups. Shell elongated, narrow, dilated behind; apex elongated, acute, recurved; cavity concave behind, with a strong, shelly, diverging ridge on each side and a wide central groove.

Australia.

Not figured. Gray adds that the shell is most like that of *S. Orbignyana*, but has not the ridges on the inner part.

**** Tentacular arms with unequal-sized cups in ten series.*

S. SAVIGNII, Blainv. Pl. 90, fig. 414; pl. 91, fig. 413.

Body ovate, oblong; back with triangular beards, forming a series on the sides, smooth below; fins broad; arms thick, very unequal, order of length 4, 3, 2, 1, the rings of the cups toothed; two middle lines of suckers of the tentacles larger, with toothed rings. Shell ovate, oblong, rounded at each end, concentrically wrinkled, nearly flat above; strongly gibbous and elevated in the middle beneath, with a border all around. Length, 9 inches.

Red Sea.

S. APAMA, Gray.

Animal unknown. Shell oblong, elongate; posterior part much produced, sub-acute, with a strong callosity at the posterior edge of the cavity; apex blunt, rugose; anterior extremity rounded, covered with a strong cartilaginous side; central portion rather convex.

Australia.

Not figured. Shell said to resemble that of *S. Savignii*, but the posterior extremity is much more produced and sub-acute, and the inner side of the central part is not convex.

* * * * *Tentacular arms finned, with numerous, small, equal-sized cups, in eight or ten rows.*

† *Shell very narrow behind.*

S. ACULEATA, Hasselt. Pl. 90, fig. 415; pl. 91, figs. 416, 417.

Body ovate, rounded, smooth, rather pointed behind; fins broad, thick, commencing rather behind the front edge; arms elongate, unequal, order of length 4, 3, 2, 1, the cups globular, with rings minutely toothed all around; tentacular clubs with very small cups in ten or twelve rows, with distant, acute teeth on the rings. Shell ovate, oblong, tubercularly wrinkled, depressed, rounded at the ends; with a long, straight, acute beak, convex beneath in front and concave behind. Length, 13 inches.

Indian Ocean; Java.

S. ELONGATA, Fer. and Orb. Pl. 91, figs. 418, 419.

Animal unknown. Shell very elongated, narrow, pointed in front, enlarged behind, and provided with a wing-like expansion and a long acute beak; rugose above, with a medial longitudinal rib; swollen beneath, gibbous in the middle.

Red Sea.

S. SINOPE, Gray. Pl. 94, fig. 443.

Animal unknown. Shell elongate, sublanceolate; back smooth, slightly concentrically wrinkled, with a deep groove along each side of the middle; rather tapering at the upper part; apex imperfect.

China.

Described from an imperfect cuttle-bone in Brit. Mus., with reference (doubtfully) to *S. Australis*, Quoy (not of Orb.)—which I figure.

† † *Shell oblong, posterior end expanded, produced, cartilaginous, not beaked, convex beneath.*—SEPIELLA.

S. ORNATA, Rang. Pl. 91, fig. 420; pl. 92, figs. 421, 422.

Body ovate, elongated, very smooth, brown, spotted with white; fins very broad, broader behind; ears with broad, thick edges; arms short, thick, unequal, length 4, 3, 1, 2, the rings of the cups oblique, smooth on the narrow, and with short, unequal teeth on the broad edge; tentacles lanceolate, with very small, close cups of equal size in eight or ten lines, with toothed rings. Shell oblong, elongate, straight, compressed, wrinkled above, obtuse anteriorly, winged posteriorly. Length, 8 inches.

W. Coast of Africa.

S. INERMIS, Hasselt. Pl. 91, fig. 423; Pl. 92, figs. 424–429.

Body oblong, smooth, blunt behind; fins narrow in front, rather wider behind, beginning behind the front edge; cups of arms small, the rings entire on the narrow, and finely toothed on the broad edge; tentacles long, slender, without any distinct club, slightly impressed at the top externally, the cups very minute or entirely wanting. Shell oblong, elongate, straight, rounded, acuminate in front, hinder end not beaked above, expanded and produced into a cartilage behind; convex beneath, with a strong central groove.

India; China.

I include the two species *S. Sinensis* and *S. microcheirus* of Gray, as I do not find any appreciable difference: I also include *S. affinis* (fig. 426) and *S. Tourannensis* (figs. 427–429) of Souleyet, from Cochin China, which appear to me to be the young of the same species.

† † † *Shell oblong, rounded behind, beaked.*

S. ROSTRATA, d'Orb. Pl. 93, figs. 430–432.

Body thick, rounded, narrow before, obtuse behind; fins thick, narrow in front, dilated behind; arms elongate, slender, unequal, order of length 4, 3, 2, 1, the cups spherical, with very small smooth-edged rings; tentacles lanceolate, with very small numerous equal-sized cups in many lines and with toothless rings. Shell ovate, oblong, tubercularly wrinkled, depressed, broader in the middle, narrow behind, with an elongated, compressed beak; convex in front, concave and with a diaphragm behind. Length, 11 inches.

Indian Ocean; Australia.

With remarkable similarity between the shell of this species and that of *S. aculeata*, there is some difference in the outline of the animal and in the rings of the suckers. I include *S. Blainvillei*, the name of which was changed to *S. Indica*, because the former was preoccupied by Deshayes for a fossil species: the latter however, proves to be a synonym, so that *S. Blainvillei*, Fer. and Orb., could be properly used if it were not the same species as *S. rostrata* ;—which has priority over all.

S. RECURVIROSTRA, Steenstrup.

The rostrum of the shell is recurved into a form somewhat like that of an interrogation mark.

China.

S. BREVIMANA, Steenstrup.

Very similar to *S. rostrata*, but differs in its much shorter tentacular arms. Possibly a young animal.

Neither this species nor *S. recurvirostra* have been sufficiently characterized or figured.

S. MYRSUS, Gray.

Animal unknown. Shell oblong, the hinder extremity rather produced, shelly, with a slight thickening within; apex blunt, rather produced, inner surface suddenly thickened, the upper half convex, with a slight central depression.

China.

Described from a Brit. Mus. specimen; not figured.

S. MESTUS, Gray.

Animal unknown. Shell oblong, rounded behind; cavity narrow behind, rapidly widening (surface destroyed); apex elongated, acute, recurved, shelly.

Australia.

Another Brit. Mus. specimen, with a worthless diagnosis and no figure.

§ § *Sessile arms with equal small cups; upper pair with two rows of cups.*

S. RUPELLARIA, d'Orb. Pl. 93, figs. 433–437.

Body ovate-oblong, elongate, smooth, acuminated anteriorly; fins very narrow; head smooth; arms short, nearly equal, length 4, 3, 1, 2; cups spherical, oblique, in two rows on the dorsal pair and on the bases of the others, and in four rows on their ends; tentacles long, with five series of small cups and three much larger ones, with the rings rather oblique and toothed. Shell elongated, arched behind, very narrow, winged and pointed in front, very narrow and winged behind, with a medial external crest. Length, 5 inches.

Europe; Great Britain to Mediterranean; Malaga.

S. ORBIGNYANA, Fer. and Orb. Pl. 94, figs. 438, 439.

Body oblong, elongate, smooth; fins narrow, thin; head very large; arms short, unequal, order of length 1, 4, 3, 2; cups subspherical, in two rows on the base of the three upper pairs and four on the ventral pair, horny rings entire; tentacles slender, club lanceolate, the cups in five lines, with five or six very large ones in the middle line. Shell elongated, grooved above, granular; narrow and acuminated in front; narrowed, thin, rounded, and with an elongated recurved beak behind. Length, 9 inches.

Great Britain to Mediterranean.

This and the preceding species are both eaten in the Mediterranean countries.

§ § § *Sessile arms with very unequal sized cups, the middle ones largest. Shell narrowed behind.*

S. CAPENSIS, Orb. Pl. 94, figs. 440–442.

Body ovate, oblong, smooth; fins dilated behind; arms short, strong, the cups spherical, peduncled; tentacles scarcely clubbed, the cups slightly oblique in three series, the middle series with three much largest, and with the rings toothed on the inner edge. Shell much depressed, oblong, elongate, enlarged and pointed in front, tapering, thin, very obtuse and with an acute projecting beak behind. Length, 4½ inches.

Cape of Good Hope; Australia.

S. BRACHYCHEIRA, Tapparone-Canefri.

I have not been able to obtain a view of the journal in which this species is described.

Doubtful species.

S. MUCRONATA, Raf. This may equal *S. rupellaria*. *Sicily.*

S. ANTILLARUM, d'Orb. *Jamaica.*

S. CINGULATA, Costa. *Mediterranean.*

S. HEXAPUS, Gmel. = Spectre, an orthopterous insect. (See p. 90, and lower figure of frontispiece.)

Genus **HEMISEPIUS**, Steenstrup.

H. TYPICUS, Steenstrup. Pl. 94, figs. 444–447.

Body semi-oval, broad, rounded behind, its ventral margins with grooves containing on each side a row of aqueous pores, situated in nipples; head somewhat rhomboidal, eyes small; arms very short, having two rows of suckers with entire rings; tentacles short, but nearly three times the length of the arms, with well-defined clubs, bearing numerous small suckers and winged dorsally. Shell very thin, wide, the side margins straight and parallel, rounded behind, obtusely pointed in front; dorsal surface smooth, ventral surface with a pyramidal deposit of chalky plates, the apex placed to the posterior end, the striæ distant and coarse, with a central longitudinal groove.

Length, including tentacles, 2·8 inches.

Cape of Good Hope.

Family XII. BELOSEPIIDÆ.

Genus BELOSEPIA, Voltz.

Three species from the European tertiary are referred to this genus, which is doubtfully separable from *Sepia*. The principal character of the shell is the hood of chalky plates, which covers the posterior end; these partitions are regularly placed and separated by cavities. The rostrum is thick, turned towards the back; the wing-like extensions of the shell are chalky.

S. SEPIOIDEA, Blainv. Pl. 95, figs. 448, 449. Eocene, *London.*

Genus COCCOTEUTHIS, Owen.

Two fossil species from the Jurassic of Europe are included under this name. They resemble Sepia in having the dorsal side of the shell granulated, but the ventral side is horny instead of chalky; the posterior end has long wing-like expansions.

C. HASTIFORMIS, Rüppell. Pl. 95. fig. 450. *Solenhofen.*

Family XIII. BELEMNITIDÆ.

The shell of Belemnites consists fundamentally of:—

1. A hollow cone, the *phragmocone* (figs. 451, 452), with a thin shelly wall, termed the *conotheca*, and which is divided by transverse septa, concave above and convex below, into chambers or loculi; the chambers are perforated near the ventral margin by a *siphuncle.*

2. A *guard* or *rostrum* more or less extensively enveloping the apical part of the phragmocone. "The phragmocone is not a chambered body made to fit into a conical hollow previously formed in the rostrum, as some have conjectured, but both the rostrum and cone grew together; the former was formed on the exterior of a secretive surface, and the latter on the interior of another secretive surface." (PHILLIPS.)

The rostrum is composed of calcareous matter arranged in fibres perpendicularly to the planes of the laminæ of growth. Professor Owen describes the fibres, in specimens from Christian Malford, as of a trihedral prismatic form, and one two-thousandth of an inch in diameter. These fibres are disposed concentrically around an axis, the so-called apical line, which extends from the extremity of the phragmocone to that of the rostrum. Indications of a thin capsule or formative membrane appear in some *Belemnites* investing the guard; in those of the Oxford clay it is represented by a granular incrustation; in some liassic species it appears in delicate plaits, like ridges or furrows; in some specimens of *Belemnitella mucronata* from the upper chalk of Antrim, it is in the form of a very thin nacreous layer.

3. A *pro-ostracum*, or anterior shell, which is a dorsal extension of the *conotheca* beyond the end where the guard disappears. The surface of the conotheca is marked by lines of growth, and, according to Voltz, it may be described in four principal regions radiating from the apex; one dorsal, with loop lines of growth, advancing forward; two lateral, separated from the dorsal by a continuous straight or nearly straight line, and covered with very obliquely arched striæ in a hyperbolic form, in part nearly parallel to the dorso-lateral boundary line, and in part reflexed, so as to form lines in retiring curves across the ventral portion nearly parallel to the edges of the septa. There were at least three kinds of pro-ostracum in the family *Belemnitidæ*.

A. In many *Belemnites* the extension of the *conotheca* seems to run out in one simple broad plate, as in *B. hastatus*, from Solenhofen (fig. 453).

B. In *Belemnites Puzosianus*, d'Orbigny, the pro-ostracum is very thin, and apparently horny or imperfectly calcified in the dorsal region, supported laterally by two long, narrow, parallel, calcareous plates (*B. Puzosianus* from the Oxford clay, fig. 454). Professor Huxley considers this difference between the pro-ostraca of generic importance.

C. The third kind of pro-ostracum is exhibited by *Orthocera elongata*, De la Beche, the type of the genus Xiphoteuthis, Huxley (fig. 460). It is calcareous, and is composed of concentric lamellæ, each of which consists of fibres disposed perpendicularly to the plane of the lamella; the phragmocone is very long and narrow, and the guard cylindroidal.

Professor Huxley suspects that a thoroughly well-preserved specimen of *Belemnoteuthis* will some day demonstrate the existence of a fourth kind of pro-ostracum among the Belemnitidæ.

"The *Acanthoteuthes* of Munster, so far as they are known only by hooks and impressions of soft parts, may have been either *Belemnites*, or *Belemnoteuthis*, or *Plesioteuthis*, or may have belonged to the genus *Celœno*." (HUXLEY.)

The genus *Belopeltis*, Voltz, was founded on the pro-ostraca of *Belemnites*.

The genus *Actinocamax*, Miller, was founded on the guards of *Belemnites* and *Belemnitella*, the upper parts of which had decayed, and thus presented no alveolar cavity. (WOODWARD.)

Genus **BELEMNITES**, Lam.

These animals, supposed to have been gregarious, from the number of their remains found in certain localities, were very numerous in species, over 100 having been described from the liassic and chalk formations of Europe, from the chalk of Southern India, from the Jurassic of the Himalayas, etc.

The phragmocone is very delicate, and its preservation is usually due to the infiltration of calcareous spar into its chambers. M. d'Orbigny supposes that the variation of the proportions of the guard, as compared with the phragmocone, being sometimes only a half-inch longer than the latter, and sometimes one or two feet, depends partly on age and sex.

D'Orbigny has presented the following scheme of sections and subsections for dividing the large number of species of *Belemnites;* they have been generally adopted.

Section I. ACŒLI, Bronn. Rostrum without dorsal or ventral grooves at its anterior end.

Subsection 1. *Acuarii*, Orb. Rostrum more or less conical, without lateral furrows, but often channeled at the posterior end. Jura., Chalk. 20 species.

Subsection 2. *Clavati*, Orb. Shell lengthened, with lateral furrows. Lias., 3 species.

Section II. GASTROCŒLI, Orb. Rostrum with an anterior ventral groove.

Subsection 3. *Canaliculati*, Orb. Rostrum without lateral grooves. Jura., 5 species.

Subsection 4. *Hastati*, Orb. With two long lateral grooves. Jura., Chalk, 19 species.

Section III. NOTOCŒLI, Orb. With a deep dorsal groove.

Subsection 5. *Dilatati*, Orb. With lateral grooves. Neocomian, 9 species.

B. EXCENTRICUS. Pl. 95, fig. 455. Oxford. Oolite of *England*.

B. SEMIHASTATUS. Pl. 95. figs. 456, 457. Jurassic of *Wurtemburg*.

B. SEMIHASTATUS. Phragmocone; view of siphonal side (fig. 457).

Genus HELICERAS, Dana.

H. FUGIENSIS, Dana. Pl. 95, fig. 458. In slate rock. *Cape Horn*. Only species.

Genus BELEMNITELLA, d'Orb.

Six species are found in the upper greensand and chalk of Europe and North America.

B. MUCRONATA, Sowb. Pl. 95, fig. 459. *Maestricht*.

Genus XIPHOTEUTHIS, Huxley.

Founded on a single English liassic species.

X. ELONGATA, De la Beche. Pl. 95, fig. 460. *Lyme Regis*.

Genus ACANTHOTEUTHIS, Wagner.

Oolitic. Seventeen species.

A. ANTIQUUS, Cunnington. Pl. 95, fig. 461. Oxford clay of *Wiltshire, Eng*.

Genus **CONOTEUTHIS**, d'Orb.

C. Dupinianus, d'Orb. Pl. 95, fig. 462. Neocomian of *France.* Only species.

Genus **BELEMNOSIS**, Edwards.

B. plicata, Edwards. Pl. 95, fig. 463. Eocene, *London.* Only species.

Genus **BELOPTERA**, Desh.

Four species. Eocene of Paris and Bracklesham.

B. belemnitoides, Blainv. Pl. 95, figs. 464, 465. *Paris.*

Genus **SPIRULIROSTRA**, d'Orb.

S. Bellardii, d'Orb. Pl. 95. fig. 466. Tertiary of *Turin.* Only species.

Family XIV. SPIRULIDÆ.

Genus **SPIRULA**, Lam.

Although thousands of shells of these pelagic mollusks are washed ashore in all parts of the world, the animal is almost unknown; but two perfect specimens having been obtained in New Zealand, which, with two or three of other individuals in bad condition, have been carefully examined by Prof. Owen and others.

Prof. Owen's last memoir on the *Spirula* adds materially to what was heretofore known respecting this strange animal.* He shows that the mantle terminates posteriorly in two lateral flaps which cover the sides of the shell, and leaving it partly exposed dorsally and ventrally. Posteriorly, between the lobes is an elliptical convex-body with a central depression or disk, flanked by a pair of oblong productions, perhaps homologous with fins, or at any rate resembling the small lateral-terminal fins of *Loligopsis.* The terminal disk is, perhaps (as long ago described by Rumphius), a true sucker, enabling the animal to

* *Ann. Mag. Nat. Hist.*, 5 ser., iii, 1, 1879.

attach the posterior end of its body to any object, leaving the arms free to exercise their prehensile power on passing objects of food. This wonderful terminal sucking organ is not found in any other cephalopods, but may have been possessed by the animal of Ammonites, supposing it to have been related to the *Spirula* rather than the *Nautilus*. The anatomy of *Spirula*, which is carefully worked out and illustrated in Prof. Owen's memoir, shows it to belong to the dibranchiate decapod cuttle-fishes, as already indicated by previous studies. Whilst *Spirula* possesses natatory powers superior to the *Nautilus*, in the action of its webbed arms, additional to that of the funnel, the former are so small in proportion to the size of the animal, and the fins are so rudimentary as to indicate sedentary habits. Prof. Owen observes that in *Spirula*, as in *Nautilus*, "the shell serves as the *point d'appui* of the retractors of the funnel and of the head with its locomotive and prehensile organs. Moreover, the last chamber of the shell in *Spirula* also receives part of the visceral mass, viz., the hind termination of the liver, which, covered by its capsule, and this again by the peritoneum or a delicate aponeurosis continued from the attached shell-muscles, constitutes the hemispheric mass that fills the chamber and forms or sends off the beginning of the membranous siphon.

In another memoir, Prof. Owen shows that the dorsal portion of the animal of *Spirula* is placed towards the outer wall of the shell, which is the reverse of the relative positions of animal and shell in both *Nautilus* and *Ammonites*, showing that the spiral growth of the shell cone took a contrary direction. He agrees that the aptychi are developed on the spadix of *Ammonites*, and are true opercular bodies; consequently the *Ammonite* could not have been like the *Spirula*, an internal shell, but must have been closely related to *Nautilus*.*

According to some recent investigators, there is a marked resemblance between the recent *Spirula* and the fossil *Ammonites*, particularly in the initial whorl, and a difference in the latter character between *Ammonites* and *Nautilus* which indicates that the *Ammonites* should be separated from the tetrabranchiate and united with the dibranchiate cephalopods. If this should prove

* Owen, on the Relative Positions to their Constructors of the Chambered Shells of Cephalopods. *Zool. Proc.*, 955, 1878.

to be so, then the *Spirula* will assume a new importance to us as the last vestige of a numerous group, else extinct.

Three species have been described, which are thus differentiated by Gray:

Posterior part of the body holding the shell by the lateral mantle flaps only, so that its last whorls are exposed below as well as dorsally and ventrally. S. PERONII, Lam.

Posterior part of the body furnished with a circular disk below, covering and concealing the shell, and having semicircular fin-like appendages on each side. S. LÆVIS, Gray.

Posterior part of the body as in *S. lævis*; mantle pitted with close set angular depressions, giving it a well-marked, reticulated character. S. VULGARIS, Leach.

It was first conjectured by Owen* that the difference between *S. Peronii* and *S. lævis* might be sexual; but it is now plain that in the animal of *S. Peronii* examined, the disk had been torn off, an accident which might readily occur when we consider the tenacity with which the suckers adhere to foreign objects. It is questionable whether the "reticulations of the mantle" in *S. vulgaris* are specific; they may result from a state of irritation, as in the octopods. I am not disposed to place much dependence on these differences. The shells seem to be indistinguishable, and it will be safest to give them the name of *S. Peronii* for the present.

S. PERONII, Lam. Pl. 96, figs. 467–469; pl. 105, fig. 585.

Animal as described in the family characters (p. 103). Shell nacreous, cylindrical, conical, tapering, involute on the same plane, the whorls separate from each other and chambered; septa concave outwards, with a shelly, ventrally placed funnel-shaped siphonal tube attached to each; last chamber rather the largest; the nuclear chamber roundish, swollen. Usual diameter, 20–22 mill.

Tropical Atlantic and Pacific Oceans.

Shells are drifted occasionally upon the Atlantic shores of the United States as far north as New England, Mediterranean, Great Britain. Very common in the Caribbean Sea and on the shores of Australia, New Zealand, Cape of Good Hope, etc.

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* *Zool. Voy. Samarang.*

If we regard strictly the rules of priority, this species will bear the name of *S.* (*Nautilus*) *spirula*, Linn.; whilst those of *S. prototypus*, Peron, and *S. fragilis*, Lam., are both antecedent to *S. Peronii*. I allow the latter name to stand because it is so well known that to displace it in favor of either of the others would create uncertainty and confusion. It may be remarked that two pre-Linnean authors perceived its generic distinctness from Nautilus with which Linnæus confounded it; and one of them, Browne, only published a year too soon to have his generic name of *Lituus* adopted.

ORDER II. TETRABRANCHIATA.

Animal breathing by two pairs of internal, symmetrical gills or branchiæ.

Eyes pedunculated. Mandibles calcareous. Arms (tentacles) very numerous, not provided with sucking disks. Body attached to the shell by adductor muscles and the mantle by a continuous horny girdle. Siphon an incomplete tube formed by the union of two lobes. No ink-bag. Creeping, and protected by an external concamerated shell, the last chamber of which it inhabits.

Shell formed of two layers, the external porcelanous, the internal and the septa or partitions nacreous. Partitions pierced by siphon-tubes.

Nearly two thousand fossil species of cephalopods have been referred to the tetrabranchiates, although it has been recently suspected that at least a large portion of these were internal shells like the Spirulas and referable therefore to the dibranchiata. Only a half-dozen recent species are known; all belonging to the genus *Nautilus*.

The tetrabranchiate shell is essentially an elongated cone, divided off into chambers by partitions, and siphunculated. These septa have simply curved edges in *Nautilus* and *Orthoceras*, they are zig-zag in *Goniatites*, or foliaceous, forming complicated lobes in *Ammonites*. The shell may be straight, curved, open or close spiral, and even vary in form at different ages, and these variations, when well understood, will doubtless cause a large reduction to be made in the number of generic forms at present accepted. The following synopsis will exhibit these variations in the genera.

Form of Shell.	Nautilidæ.	Ammonitidæ. With undulating sutures.	Ammonitidæ. Sutures toothed at the base.	Ammonitidæ. Sutures complex lobed or foliaceous.
Straight	Orthoceras	Bactrites	Baculina.	Baculites.
				Rhabdoceras
	Gomphoceras.			
Bent or curved	Cyrtoceras			Toxoceras.
	Phragmoceras			
Discoidal spire and free whorls	Ascoceras			
	Gyroceras			Cryoceras.
Ibid. Finally straight or hook-shaped	Lituites			Ancyloceras.
Hook-shaped or bent upon itself more than once, whorls free				Hamites.
Ibid. Straight portions in contact				Ptychoceras.
Involute, spiral	Nautilus.	Goniatides.	Ceratites.	Ammonites.
	Nothoceras			
	Clymenia			
				Clydonites.
Involute; last chamber detached, hook-shaped				Scaphites.
Elongated, spiral, whorls in contact				Turrilites.
				Cochloceras.
Spiral, elongated, whorls not in contact	Trochoceras.			Helicoceras.
Spiral, elongated, the last whorl free, produced and recurved.				Heteroceras.

Order II. TETRABRANCHIATA.

Family 1. Nautilidæ. Septa simply curved, concave on the outer face, sutures simple, or undulate or lobed; mouth simple; siphonal opening nearly central. Shell but little sculptured, or smooth.

Six living and about 600 fossil species.

Family 2. Ammonitidæ. Septa convex in their median section, sutures complex, lobed, ramified or denticulated; septal tube cylindrical and always directed forwards; siphuncle cylindroid, small, marginal, the siphonal investment more or less solid and persistent.

Fossil only, about 1600 species (?) known.

Family I. NAUTILIDÆ.

Genus ORTHOCERAS, Breyn.

Shell straight; aperture sometimes contracted.

Fossil, 240 species. L. Silurian to Liassic; N. America, Australia, Europe.

Probably the animal was not able to withdraw itself completely into its shell, as in the Nautilus. That the shell was external is indicated by the colored bands preserved on *O. anguliferus*.

These shells attained sometimes great size; a specimen in the collection of Mr. Tate, of Alnwick, England, must have been six feet long when perfect. *O. Titan* is estimated to have weighed "some tons."* The aperture is sometimes so contracted that species two feet in length have a diameter of only one inch at the mouth.

O. PLANICANALICULATUM, Sandb. Pl. 96, fig. 470. Devonian. *Nassau*.

O. SUBANNULARE, Barr. Pl. 96, fig. 471. Silurian, *Bohemia*.

The following subgenera or groups are generally adopted:

Cameroceras, Conrad.

Siphuncle lateral, sometimes very large (simple?).

Twenty-seven species. L. Silurian to Triassic? *N. America, Europe.*

C. VERMICULARIS, d'Arch. Pl. 96, fig. 472.

C. VAGINATUS, Schloth. Pl. 96, fig. 473.

Actinoceras, (Brown), Stokes.

Siphuncle very large, inflated between the chambers and connected with a slender central tube by radiating plates.

Six species. L. Silurian to Carb. *N. America, Europe.*

A. RICHARDSONI, Stokes. Pl. 96, fig. 474. *L. Winnepeg.*

A. BIGSBYI. Pl. 96, fig. 475.

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* Newberry, Palæont. Ohio, i, 263.

Ormoceras, Stokes.

Siphuncular beads constricted in the middle, so that the septa appear as if united to the centre of each. Probably identical with *Actinoceras*.

Three species. L. Silurian to Devonian. *N. America.*

O. Bayfieldi, Stokes. Pl. 96, fig. 476.

Huronia, Stokes.

Shell extremely thin, membranous or horny (?). Siphuncle very large, central, upper portion of each joint inflated, connected with a small central tube by radiating plates.

Three species. L. Silurian. *Drummond Isl., L. Huron.*

Usually the siphuncle only is preserved. Dr. Bigsby observed specimens six feet in length. Doubtfully distinct from *Actinoceras.*

H. vertebralis, Stokes. Pl. 96, fig. 477.

Aulacoceras, Hauer.

Shell much thickened, longitudinally furrowed, with two deep lateral sulcations; siphon very small, marginal and dorsal.

Four species. Upper Triassic. *Austria.*

A. sulcatum, Hauer. Pl. 96, fig. 478.

Bathmoceras, Barrande.

Part of the body-chamber occupied by imbricating plates, decreasing in horizontal extension from below upwards; siphuncle a series of superimposed funnel-shaped tubes.

Two species. Middle Silurian. *Bohemia.*

Endoceras, Hall.

Shell extremely elongated, cylindrical. Siphuncle very large, cylindrical, lateral; thickened internally by repeated layers of shell, or partitioned off by funnel-shaped diaphragms.

Twelve species. L. Silurian. *New York.*

Endoceras. Ideal section. Pl. 96, fig. 479.

E. proteiforme, Hall. Pl. 96, fig. 480.

Tretoceras, Salter.

Founded on *O. bisiphonatum*, Sowb., from the Caradoc sandstone (Silurian), Brit., in which the septa are apparently perforated by two siphuncles; one of which is a deep lateral cavity continuous with the terminal chamber—the cavity affecting at least seven of the uppermost septa, if not the whole.

T. BISIPHONATUM, Sowb. Pl. 97, fig. 481. Silurian. *Wales.*

Thisoa, Montf.

Shell ovate-elongate, cucumber-shaped; apparently two siphons running parallel the whole length of the shell, one of which traverses a sort of narrow lateral cavity; there are also a number of false siphons or holes, which do not extend the entire length of the shell.

T. SIPHONALIS, Serres. Pl. 104, figs. 571, 572. Jurassic. *France.*

Gonioceras, Hall.

Shell flattened, with extremely salient angles; septa sinuous; section of shell, an extended ellipse with projecting angles; siphuncle ventral.

G. ANCEPS, Hall. Pl. 97, figs. 483, 484. L. Silurian.

Colpoceras, Hall.

This is probably only a siphon of one of the larger species of Orthocerata.

C. VIRGATUM, Hall. Pl. 97, fig. 485. L. Silurian. *New York.*

Dictyoceras, Eichw.

Is probably an Orthoceras covered by a bryozoan or coral.

Genus CLINOCERAS, Mascke.

Shell conical (allied to *Loxoceras*, McCoy), the siphuncle side straight, the others more or less curved; a constriction below the body-chamber. Septal border with an obtuse-angled saddle on the siphuncle side, with gently rounded lobes and two slightly marked lateral saddles.

C. DENS, Mascke. Pl. 105, fig. 587. Erratic L. Silurian blocks. *Prussia.*

Genus **PILOCERAS**, Salter.

Shell broad, conical, subcylindrical or compressed, slightly curved. The siphuncle and septa represented by a series of conical septa, concave to a central point.

Fossil, three species. L. Silurian. *Canada; Scotland.*

PILOCERAS. Idéal section. Pl. 97, fig. 486.

Genus **CYRTOCERAS**, Goldfuss.

Shell curved; siphuncle small, subcentral.

Fossil, eighty-four species. L. Silurian to Carb. *N. and S. America; Europe.*

Seems to differ but little from *Orthoceras*.

C. ACUTICOSTATUM, Sandb. Pl. 97, fig. 487.

Subgenera:

Oncoceras, Hall.

Anterior half of the shell inflated, aperture more or less strangulated. This may possibly = *Phragmoceras*, Brod.

Silurian. *New York.* Three species.

O. CONSTRICTUM, Hall. Pl. 97, fig. 488.

Cyrtocerina, Billings.

Shell short and thick, with a large siphuncle, placed dorsally.

Two species. Silurian. *Canada.*

Streptoceras, Billings.

Shell like Oncoceras, but the aperture trilobed.

Two species. Middle Silurian. *Canada.*

Genus **GOMPHOCERAS**, J. Sowb.

Shell fusiform or bottle-shaped, straight, swollen anteriorly; aperture contracted in the middle; siphuncle subcentral; septa simple, concave.

100 species. L. Silurian to Carb. *Europe; N. America.*

G. PYRIFORME. Pl. 97, fig. 489. Silurian. *England.*

G. BOHEMICUM, Barr. Pl. 97, fig. 490. Aperture.

Genus **SYCOCERAS**, Pictet.

Shell oval or bottle-shaped, straight; septa simple; siphuncle marginal.

Silurian. Devonian.

S. ORTHOGASTER, Sandb. Pl. 97, fig. 491.

Genus **ASCOCERAS**, Barr.

Shell flask-shaped; the terminal chamber not only fills the front of the shell, but extends down the ventral side, nearly its whole length, as a deep cavity, which is embraced by the decurrent edges of the four or five incomplete septa; a minute siphuncle on the dorsal side.

Sixteen species. L. and U. Silurian. *Europe; Canada.*

A. BOHEMICUM, Barr. Pl. 97, fig. 492.

Genus **GLOSSOCERAS**, Barr.

Shell like *Ascoceras*, but the dorsal margin of the aperture ligulately extended and incurved.

Two species. Middle and U. Silurian. *Anticosti*, *Bohemia.*

Genus **APHRAGMITES**, Barr.

Shell like *Ascoceras*, but the septa are deciduous.

Two species. U. Silurian. *Bohemia.*

Genus **PHRAGMOCERAS**, Brod.

Shell compressed on the sides, curved; aperture contracted in the middle; last chamber large; siphuncle ventral, with radiations; septa simple.

Fifteen species. Silurian to Devonian. *Europe.*

PH. VENTRICOSUM, Stein. Pl. 97, fig. 493. Silurian. *England.*

PH. CALLISTOMA, Barr. Pl. 98, fig. 494. Aperture.

Genus **GYROCERAS**, Meyer.

Shell planorboid, with separated whorls; septa simple, but little curved; siphuncle subdorsal, with radiations; last chamber large; mouth but little contracted.

Seventeen species. Silurian to Triassic (?). *Europe; N. America.*

G. GOLDFUSSII. Pl. 98, fig. 495. Devonian. *Eifel.*

Genus NOTHOCERAS, Barr.

Shell nautiloid, slightly involute; septa but little curved, not lobed.

One species. U. Silurian. *Bohemia.*

N. BOHEMICUM, Barr. Pl. 97. fig. 496.

Genus HERCOCERAS, Barr.

Shell generally nautiloid, the whorls sometimes separated, or even turbinate; body-chamber with a diaphragm perpendicular to the axis of the shell, the concavity of which is opposed to that of the last septum, throwing the aperture on the deeply excavated dorsal side of the shell; siphuncle dorsal, cylindrical, inflated between the chambers, separated from the shell.

Two species. Middle Silurian. *Bohemia;* Devonian. *Nassau* (?).

Genus LITUITES, Breyn.

Shell planorbiform, the whorls close or separate; the last chamber produced in a straight or outwardly curved line; lateral margins of the aperture extended and curved towards the interior of the shell, contracting the aperture into two distinct orifices.

Twenty-eight species. Silurian. *Europe ; North America.*

L. SIMPLEX, Barr. Pl. 98, fig. 497.

Subgenus Ophidioceras, Barrande.

Shell with the produced portion very short or wanting.

Seven species. Silurian. *Norway*; *Bohemia.*

Genus DISCOCERAS, Barrande.

Shell planorbiform; produced portion very short or wanting; aperture simple, not contracted.

Three species. Middle Silurian. *Russia ; Germany ; Norway.*

M. Barrande describes this as a subgenus under his genus *Lituunculus;* of which no species have been observed, but which he creates by anticipation with the diagnosis: "Shell like *Lituites*, but with a simple aperture," in order that *Discoceras* may hold the same relationship to it that *Ophidioceras* does to *Lituites!* This is filling up the "gaps" with a vengeance, and could scarcely have been predicated of the renowned Bohemian anti-developmentalist.

Genus PTERONAUTILUS, Meek.

Shell spiral, involute, finally produced, with lateral wing-like expansions.

P. Seebachianus, Geinitz. Pl. 98, fig. 498. Permian.

Genus CLYMENIA, Münst.

Shell discoidal, with many but slightly involute whorls; septa simple or slightly lobed; siphuncle near the inner wall.

Fifty species. Upper Silurian. Devonian. *Europe; North America.*

C. undulata, Münst. Pl. 98, fig. 499. *Fichtelgebirge.*

Genus SUBCLYMENIA, d'Orb.

Shell spiral, planorbiform; sutures of septa sinuous, not angular on the sides, but with a simple dorsal lobe.

One species. Devonian. *England.*

S. evoluta, d'Orb. Pl. 98, figs. 500, 501.

Genus TROCOCERAS, Barr.

Shell depressed, spiral, nautiloid or nearly discoidal; whorls free; septa simple. Very closely related to *Lituites.*

Forty-four species. U. Silurian. *Bohemia.*

Genus NAUTILUS, Breyn.

Shell involute or discoidal, few-whorled; septa concave, simpie; siphuncle nearly central.

Outer surface smooth in the recent species, but corrugated in some of the fossil ones.

Animal placed with its ventral face to the convex (dorsal) wall of the shell.

Six living, and nearly two hundred fossil species.

They are divided into the following groups:

1. Lævigati. Shell smooth. Permian—Living.
2. Radiati. Shell transversely ribbed. Principally cretaceous.
3. Striati. Shell longitudinally striate. Oolite of Europe, and Lower Chalk, India.

Recent species of Nautilus.

Pl. 99, fig. 506 is an ideal view of the animal of Nautilus, with the tentacles expanded.

The three best known species of the genus *Nautilus* are *N. Pompilius*, *N. macromphalus* and *N. umbilicatus*. The first species is the most common and has the widest range; the second species is more limited in its range and rarer; the third, although found in collections, is scarcer than the two preceding, and has a range peculiar to itself. The range of *N. Pompilius* embraces the islands of the Eastern Archipelago, Erromanga, Aneitum, and other islands of the New Hebrides and also the Feejee group. *N. macromphalus* is found about the Isle of Pines and New Caledonia; and the rare *N. umbilicatus* in the Solomon Archipelago, New Georgia, New Britain, New Ireland, and probably to the eastward of these groups of islands. Dr. Macdonald, of H. M. S. *Herald*, informs me that on examination and comparison, there is a marked difference between the tentacula in the first two species. The sculpturing on *N. umbilicatus* is very distinctly marked on the external surface of the shell, differently from what is observed either in *N. Pompilius* or *N. macromphalus*, and forming one of its very distinctive characters. The outer edge of the lip of the perfect shell in *N. umbilicatus* has a narrow, black rim, continuous from the anterior portion of the whorl. In *N. Pompilius* and *N. macromphalus*, the black rim is on the inner side of the edge of the lip. The color of the shells in the different species varies from brick-red and orange of brighter or paler tints, to nearly a dark crimson color, being as various as the colors observed in the common cowrie shells.*

N. Pompilius, Linn. Pl. 99, figs. 507, 508.

Shell sub-orbicular, smooth, imperforate, the umbilicus being covered by a callous deposit. White, flamed transversely with red.

Polynesia.

During the voyage of the *Challenger*, a living *N. Pompilius* was dredged in 320 fathoms, off Matuka Island, Fiji group. It was very lively, swimming around in a tub, in a retrograde direction by the ejection of water from the funnel. The tenta-

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* Bennett, *Proc. Zool. Soc.*, 226, 1859.

cles were extended radially from the head, somewhat like those of a sea anemone; but each pair had its definite and different direction, which was constantly maintained; thus one pair of tentacles was held pointing directly downwards, two other pairs, situate just before and behind the eyes, were held projecting obliquely outwards and forwards, and backwards respectively, as if to protect the organs of sight.*

N. STENOMPHALUS, Sowb. Pl. 99, fig. 509.

Shell like *N. Pompilius*, but very narrowly umbilicated.

Eastern Archipelago.

I scarcely think this deserves to be separated from *N. Pompilius;* the very narrow umbilicus is exposed simply because the callous deposit has not spread sufficiently to cover it; there is no excavation around the umbilical region, as in the following species.

N. MACROMPHALUS, Sowb. Pl. 99, fig. 510.

Umbilical region excavated, but with rounded margin; umbilicus wide, exposing the whorls.

New Caledonia, etc.

N. UMBILICATUS, Lister. Pl. 99, fig. 511.

Surface smooth to spirally striate; umbilical region wide, angularly excavated, umbilicus wide, showing all the whorls.

Solomon Islands, New Ireland, etc.

The striæ are not constant; I have therefore reunited with this species *N. scrobiculatus* of Dillwyn and Gould and *N. perforatus*, Conrad.

Subgenus **Aturia**, Bronn.

Sutures of septa with a deep lateral lobe; siphuncle on the concave or inner side of the shell, large, continuous, like a succession of funnels.

Four species. Eocene. *N. America; Europe; India.*

A. ZICZAC, Sby. Pl. 98, figs. 502, 503 *a*. Eocene. *British.*

Subgenus **Discites**, McCoy.

Whorls all exposed; last chamber sometimes produced.

Five species. L. Silurian—Carb.

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* Mosely, Notes by a Naturalist on the *Challenger*, 296.

Subgenus **Temnocheilus**, McCoy.

Shell carinated, with an open, conical umbilicus.

Five species. Carb. limestone.

T. BIANGULATUS, Sowb. Pl. 98, fig. 503.

Subgenus **Trematodiscus**, Meek and Worthen.

Like *Temnocheilus*, but dorsal or outer side of whorls with revolving angles and sulci, and frequently, revolving striæ.

Carboniferous. *Europe; America.*

T. TRISULCATUS, Meek and Worthen. Pl. 98, fig. 504 *a, b*. Subcarboniferous. *Rockford, Ind.*

Subgenus **Cimomia**, Conrad.

Septa sinuous, double waved or sigmoid, numerous; siphon small, central.

N. BURTONI, Galeotti. Lower Eocene.

Subgenus **Hercoglossa**, Conrad.

Septa angular and linguiform; apex of the angle or tongue-shaped lobe not contiguous with the adjacent septum; siphon large or moderate, situated within the centre, or between the middle and the inner margin, and not dorsal or funnel-shaped, but tubular and gradually tapering.

Eocene. Cret. *Europe; America.*

A very doubtful group, as Conrad includes species having respectively the characters of *Aturia* and of *Nautilus;* the type species, however, *N. orbiculatus* of Tuomey, has not been figured.

Subgenus **Pseudonautilus**, Meek.

Differs from *Hercoglossa* in the septa being provided with a well-defined peripheral and antiperipheral lobe, and the siphuncle placed near the outer margin.

NAUTILUS GEINITZI, Oppel.

Subgenus **Cryptoceras**, d'Orb.

Planorbiform; septa arcuated, without lobes or sinuosities; siphon dorsal.

Two species. Devonian, Carboniferous. *Europe.*

C. SUBTUBERCULATUS, d'Orb. Pl. 98, fig. 504.

Family II. AMMONITIDÆ.

The lobes and saddles of Ammonites are figured in pl. 103. figs. 565–567; pl. 104, figs. 568–570.

Genus **BACULITES**, Lam.

Shell straight, elongated, conical; suture foliately lobed; last chamber large; margin of aperture dorsally produced.

Fourteen species. Cretaceous. *Europe; Chili; India; United States.*

The baculite limestone of Normandy is so called from the numerous remains of the shells of this animal which it contains.

B. ANCEPS, Lam. Pl. 100, fig. 523. *France.*

B. BACULOIDES, d'Orb. Pl. 100, fig. 524.

Conrad has given the name *Cycloceras* to a Baculite figured by him, but without generic characters; afterwards, finding that name preoccupied by McCoy, he changed it to *Cyclomera*, still giving no diagnosis.

Meek divides *Baculites* into two subgeneric forms, which, he remarks, are possibly distinct genera.

1. **Baculites**, Lam. (typical).

a. Shell straight throughout; aperture directed forward; lip with lateral sinuses directed backward; the projection of its siphonal margin, straight, and its antisiphonal margin convex in outline; interior without regularly disposed ridges. Type, B. VERTEBRALIS, Lam.

(?) *b.* Shell straight posteriorly, but with the non-septate part gently arcuate; aperture a little oblique; appendage of siphonal side of lip arching slightly with the general curvature of the non-septate part, but not curving over the aperture. B. INCURVATUS, Dujardin.

2. **Cyrtochilus**, Meek.

Shell straight; aperture opening towards the antisiphonal side, and the lateral sinuses of the lip excavated in the opposite direction; projection of siphonal margin of lip abruptly arching over the aperture, and the antisiphonal margin of same deeply sinuous instead of convex in outline; interior with regularly disposed ridges, leaving oblique constrictions on internal casts. HAMITES BACULOIDES, Mantell = B. OBLIQUATUS, Sowb.

Genus **BACULINA**, d'Orb.

Shell straight, point conical; sutures of septa a row of rounded lobes, toothed at base.

Two species. Jurassic, Lower Chalk. *Europe.*

B. ARCUARIA, Quenstedt. Pl. 100. fig. 517.

Genus **RHABDOCERAS**, Hauer.

Shell straight, orthoceratoid, strongly sculptured; septa with rounded lobes.

One species. Alpine Triassic. *Germany.*

R. SUESSII, Hauer. Pl. 100, figs. 513, 514.

Genus **BACTRITES**, Sandberger.

Shell straight; sutures lobed.

Three species. Devonian. *Germany.*

B. GRACILIS. Sandb. Pl. 100. fig. 515. *Nassau.*

Genus **TOXOCERAS**, d'Orb.

Shell horn-shaped or curved; the six lobes and saddles of the sutures simply crenulated; last chamber large.

Twenty species. Neocomian, *France.*

Connected with *Crioceras* and *Ancyloceras* by numerous intermediate forms.

T. BITUBERCULATUS, d'Orb. Pl. 100, fig. 525.

Genus **HAMULINA**, d'Orb.

Differs from *Hamites* in being only once bent upon itself, not in contact. Perhaps should not be separated from *Hamites.*

Twenty species. Neocomian. *France;* Gault (?), *India.*

H. TRINODOSA, d'Orb. Pl. 101, fig. 535.

Genus **HAMITES**, Parkinson.

Shell conical, hook-shaped, bent upon itself more than once, the courses separate.

Thirty-eight species. Chalk. *Europe; S. America.*

H. ATTENUATUS, Sowb. Pl. 101, fig. 533. *England.*

H. CYLINDRACEUS, Defr. Pl. 101, fig. 534.

Genus **PTYCHOCERAS**, d'Orb.

Shell bent once upon itself; the two straight portions in contact.

Eight species. Neocomian to Cretaceous. *Europe; India; United States.*

P. Emericianus, d'Orb. Pl. 101, fig. 536. *France.*

Subgenus **Diptychoceras**, Gabb.

Three straight limbs in contact. A *Ptychoceras* in every respect except that it has an additional limb which incurves, enveloping both the preceding to a slight degree only. Meek considers it doubtfully identical with *Ptychoceras.*

Genus **COCHLOCERAS**, Hauer.

Shell spirally elongated, scalariform, strongly sculptured; sutures of septa with several rounded lobes.

Three species. Alpine Triassic. *Hallstatt, Austria.*

C. Fischerii, Hauer. Pl. 100, figs. 518, 519.

Genus **ANCYLOCERAS**, d'Orb.

Shell at first spiral, discoidal with separated whorls; afterwards produced at a tangent and then bent back again upon itself like a hook.

Forty species. Infer. Oolitic, Cretaceous. *Europe; South America; United States.*

A. spinigerum, Sowb. Pl. 100, fig. 526. Gault. *Folkestone.*

Genus **ANISOCERAS**, Pictet.

Shell at first spiral, helicoid, whorls separated, at length more or less prolonged and reflected; transversely ribbed; sutures of septa with five lobes and saddles, all bipartite.

Twelve species. Gault to Upper Greensand, *Europe.* Cretaceous, Jurassic, *India.*

A. Saussureanus, Pictet. Pl. 100, fig. 528.

Genus **SCAPHITES**, Parkinson.

Shell at first closely spiral, involute, at length detached and recurved; sutures many lobed, lobes foliated.

Nineteen species. Oolitic, Cretaceous. *Europe; India; United States.*

S. equalis, Sowb. Pl. 100, fig. 527. Chalk marl. *Sussex, Eng.*

Subgenus **Macroscaphites**, Meek.

Shell with inner turns merely in contact, or so slightly embracing as to leave a very large, shallow umbilicus; periphery rounded; body portion much extended from the inner volutions; surface costate. S. GIGAS, Sowb.

Subgenus **Discoscaphites**, Meek.

a. Shell with general outline subcircular or slightly oval, and generally much compressed; inner volutions forming a large part of the entire bulk, and so deeply embracing as to leave only a small umbilicus; body portion so short as scarcely to become free at the aperture, flattened on the periphery; surface ornamented with costæ, and provided on each side with from about four to nine rows of tubercles, the outer of which are largest and arranged along each margin of the periphery. SCAPHITES CONRADI, Morton.

b. Shell differing from the last chiefly in having the volutions so narrow and little embracing as to leave a large, shallow umbilicus, and the body-volution deviating very little from the regular curve of the others. S. (AMMONITES) CHEYENNENSIS, Owen.

Genus **GONIATITES**, DeHaan.

Shell spiral, discoidal; sutures of septa lobed; siphuncle dorsal.

About 200 species. Upper Silurian to Triassic. *Europe*.

G. HENSLOWI, Sowb. Pl. 100, fig. 512. Carb. limestone. *Isle of Man*.

Genus **CERATITES**, DeHaan.

Shell spiral, discoidal; slightly involuted whorls, generally strongly sculptured; sutures crenulately lobed, toothed at base.

Twenty-nine species. Devonian—Chalk. *Europe*, *India*.

C. NODOSUS, Brug. Pl. 100, fig. 516. Muschelkalk. *Würtemberg*.

Genus **BUCHICERAS**, Hyatt.

Founded on the cretaceous species of *Ceratites*, which differ from the triassic forms in the characteristics of the sutural outlines: they are not *Ceratites* at all, but, strictly speaking, *Ammonites*. They show this in the form of the abdominal cell in the young, the characteristics of the superior lateral cells, which are invariably divided, as are those of all the Ammonites proper, and also in the tendency of the young sutures of *Buchiceras bilobatum* to assume a wholly ammonitic aspect. The truly ammonitic outline of the cells and lobes in *Buchiceras attenuatum* shows how easily the outlines of the typical divided cells are transformed into those of a true Ammonite by a few digitations, whereas the same digitations applied to the entire outlines of a true *Ceratite* would produce only a Ceratite, not an Ammonite.

Genus **MEEKOCERAS**, Hyatt.

Distinguished from *Ceratites* by having but three distinct lateral cells and two lateral lobes, besides the finer auxiliary lobes and cells. The typical *Ceratites* have at least four distinct lateral cells and lobes besides the auxiliary ones, and the distinction is slight between the two series; in this genus, on the contrary, the auxiliary series, when present, is not divided from the third lateral cell by a distinct lobe, as in *Ceratites*, and the aspect of the third lateral cell is often like that of a *Goniatites*. The compressed whorls of all the species is of course a characteristic which is obvious when they are contrasted with typical *Ceratites*, as is also the absence, or merely transient appearance, of heavy nodes and ribs, except perhaps in the least involute species.

Jurassic to Triassic. *S. E. Idaho.*

Genus **CLYDONITES**, Hauer.

Shell spiral, discoidal, whorls involute; sutures simply lobed, the lobes pointed.

Twenty-one species. Upper Triassic. *Europe, Himalayas.*

Two species. Upper Cretaceous (described by d'Orb. as *Ceratites*). Difference from *Ceratites* is the lobes being simple, not crenulated.

C. COSTATUS, Hauer. Pl. 100, fig. 520.

C. DELPHINOCEPHALUS, Hauer. Pl. 100, fig. 521.

Genus **CRIOCERAS**, Leveille.

Shell discoidal, spiral; whorls separate; lobes foliated.

Thirteen species. Neocomian to U. Greensand. *Europe.*

Some of the species have been ascertained to be merely incomplete Ancyloceræ; the two genera should probably be united.

C. CRISTATUM. d'Orb. Pl. 100. fig. 522. Gault. *Southern France.*

Genus CHORISTOCERAS, Hauer.

Shell like *Crioceras*, but the lobes crenulated.

Four species. Upper Triassic. *Austria.*

Genus HELICOCERAS, d'Orb.

Shell spiral, sinistral; whorls separate; annular costæ passing uninterruptedly over the siphonal side.

Eleven species. Inferior Oolitic (?) to Cretaceous. *Europe. India, United States.*

Subgenus Patoceras, Meek.

Costæ interrupted on the siphonal side, leaving a narrow, smooth space along the whole length of the same.

H. TEILLEUXII, d'Orb. Pl. 101. fig. 529. Jurassic.

Genus TURRILITES, Lam.

Shell spiral, depressed to elongate, sinistral or dextral; sutures six-lobed, foliated; aperture often irregular.

Thirty-seven species. Gault to Chalk. *Europe.*

Helicoceras is distinguished from this genus by its separated whorls.

T. COSTATUS, d'Orb. Pl. 101, fig. 530. Chalk.

T. BOBLAYI, d'Orb. Pl. 101. fig. 531.

Genus HETEROCERAS, d'Orb.

Shell like *Turrilites*, but last chamber somewhat produced and recurved.

Five species. Cretaceous. *Europe; United States.*

H. EMERICII, d'Orb. Pl. 101, fig. 532.

Subgenus Helicancyloceras, Gabb.

Spire less elevated, volutions less decidedly in contact.

Genus **AMMONITES**, Brug.

Shell spiral, discoidal. more or less involute; septa undulated, the sutures lobed and foliated; siphuncle dorsal; margin of mouth sometimes produced into one or more horns.

About 700 species. Triassic. Cretaceous. *N. and S. America; Europe; India: New Zealand.*

A. OBTUSUS. Pl. 101. fig. 537. Liassic. *Lyme Regis.*

The young shell differs much from older specimens in the degree of involution and in being less complicated in the sutural lobes; even the external ornamentation varies, so that the above number of described species will probably be much reduced upon careful revision. As an example, *A. spendens* from the greensand, Cambridge, Eng., according to Mr. Seeley includes fourteen other so-called species from the same bed; and *A. planulatus* may include five species.

Ammonites have been discovered in the high passes of the Himalaya Mountains, over 16,000 feet above the sea.

The nominal species being so numerous, it has been usual until recently to class them in the following artifical groups:

A. Dorsal portion of whorls rounded, not keeled.

1. Fimbriati. Oolitic. A. FIMBRIATUS, d'Orb. Pl. 101, figs. 538, 539.
2. Planulati. Jura, Chalk. A. ANNULATUS, Sowb. Pl. 102, figs. 540, 541.
3. Ligati. Cretaceous. A. LIGATUS, d'Orb. Pl. 102, figs. 542, 543.
4. Globosi. Alpine Trias.
5. Heterophylli. Jura, Alpine Trias. A. HETEROPHYLLUS, d'Orb. Pl. 102, figs. 544, 545.

B. Whorls dorsally flattened.

6. Capricorni. Jura. A. CAPRICORNUS, Schloth. Pl. 102, figs. 546, 547.
7. Armati. Jura. A. LONGISPINUS, Sowb. Pl. 102, figs. 548, 549.
8. Coronarii. Jura, Chalk. A. BLAGDENI, Sowb. Pl. 102, fig. 550, 551.
9. Macrocephali. Jura. A. HERVEYI, Sowb.
10. Compressi. Chalk. A. BEAUMONTIANUS, d'Orb. Pl. 102, figs. 552, 553.

C. Dorsally channeled.

11. Dentati. Jura, Chalk. A. MAMILLARIS, Schloth. Pl. 103, fig. 554, 555.

D. Dorsally keeled, keel entire.

12. Arietes. Lias. A. BIFRONS, Brug. Pl. 103, fig. 556. A. BISULCATUS, Brug. Pl. 103, fig. 557.
13. Falciformi. Jura. A. SERPENTINUS, Schloth. Pl. 103, figs. 558, 559.
14. Cristati. Chalk. A. CRISTATUS, Deluc. Pl. 103, fig. 560.

E. Dorsal keel crenated.

15. Amalthei. Jura. A. CORDATUS, Sowb. Pl. 103, figs. 561, 562.
16. Rothomagenses. Chalk. A. ROTHOMAGENSIS, Brong. Pl. 103, fig. 563.

F. Dorsally sharp edged.

17. Disci. Chalk. A. METTERNICHII, Hauer. Pl. 103, fig. 564.

L. von Buch has attempted to distinguish a large portion of the above groups by differences in the lobation (*Abh. Akad. Berlin*, 1830), and d'Orbigny has further modified them.

Amongst the various attempts which have been made to "bring order out of chaos" in the arrangement of the Ammonites, that of Prof. Alpheus Hyatt deserves particular mention. In his article on "Fossil Cephalopods," published in the *Bulletin of the Museum of Comparative Zoology*, i, 71, this author regards the Ammonoids, including all the Cephalopods with serrated or foliated septa, the Clymeniæ, Goniatites, Ceratites, and Ammonites proper "as a distinct order from the Nautiloids and Dibranchiate Cephalopods;" the typical group of this order being the so-called genus Ammonites. This enlarged view of the systematic position of the Ammonoids is by Prof. Hyatt attributed to Prof. Agassiz, but it is evident that Von Buch had a glimmering of the same idea because his groups (mainly those I have enumerated above) although permitted by him to remain under the generic name Ammonites were designated as "families." Prof. Edward Suess, also, regarded the genus Ammonites as a family, the typical groups of which were of generic rank.

I give below the diagnoses of the families and genera in Prof. Hyatt's paper (which includes only liassic forms), premising that whilst the discoveries of the embryonic differences between the Nautiloids and Ammonoids made by Prof. Hyatt are supposed by some to indicate that the latter should be included among the dibranchiate rather than among the tetrabranchiate cephalopods, in any event, the elaborate subdivisions of the group are scarcely warranted by the very changeable characters of the species. Regarded as a convenience simply, the modified arrangement of Von Buch, which we have given, appears preferable.

Prof. Hyatt reverses the use of "dorsal" and "abdominal" in his descriptions of the shells; inasmuch as the animal of Nautilus and Ammonites is placed with its abdominal side to the periphery of the shell, he calls this outer side of the latter "abdominal," and the inner or sutural side "dorsal." In quoting his own diagnoses I have followed him, but regard this reversal of terms as objectionable, inasmuch as their exceptional use in the shells of tetrabranchiates must give rise to a great confusion. He uses also the word "pilæ" for ribs, and "geniculæ" for the knees of the ribs.

Prof. Hyatt has, subsequently to the publication of his classification (as quoted below), changed his views somewhat as to portions thereof (*Bost. Proc.*, xvi–xviii). He has adopted such extreme "development" views upon the subject, as render his later groups difficult to define. A clear exposition of the reversed position of the animal of the tetrabranchiate, in relation to its shell, may be found in a paper by Prof. Owen, *Zool. Proc.*, 955, 1878.

Family PSILOCERATIDÆ. Shell smooth, umbilicus open, exposing the sides of the whorls; sides depressed.

PSILOCERAS. Abdomen smooth; shell often folded; sides depressed; septa foliated; whorls enveloped to the line of the superior lateral lobes.

Lower Lias.

P. PSILONOTUM, Quenst. T. 106, figs. 603, 604.

Family DISCOCERATIDÆ.

ARNIOCERAS. Abdomen keeled and channeled, but both parts are variable, being sharply defined in some species, and very shallow in others. Abdominal lobe shallow and broad; not so deep as the superior lateral lobe; deeper than the inferior lateral; both divided equally. Superior lateral cell equally divided. The young retain the smooth character for some time during their growth, thus giving to the umbilicus a decidedly embryonic aspect. Envelopment extends laterally to the geniculæ.

Lower Lias.

A. KRIDION, d'Orb. T. 106, figs. 605, 606.

OPHIOCERAS. Keel constant, sometimes obscure. The shell has a greater number of whorls than in the preceding genus, because the young increase more slowly in size. Pilæ straight, depressed, appear at an early stage in the young, and are well defined upon the second whorl. Umbilicus open; sides exposed. Abdominal lobe deeper and narrower than the lateral lobes. Superior lateral lobes broad, shallow, and but very little longer than the inferior lateral. The auxiliary lateral lobes are cuneiform, and incline towards the umbilicus.

Lower and Upper Lias.

O. TORUS, d'Orb. T. 107, figs. 612, 613.

DISCOCERAS. Abdomen keeled and channeled. Both characters are constant, although the channels are sometimes nearly obsolete. Pilæ smooth. Geniculæ curved forwards. Umbilicus open, sides flattened, exposed. Abdomen depressed. Abdominal lobe deep and narrow. Superior and inferior lateral, narrow and irregularly pointed with minor lobes. Superior lateral cell equally divided. Inferior lateral unequally divided. First auxiliary cell well developed, and nearly as long as the inferior lateral.

Lower Lias.

D. OPHIDIOIDES, d'Orb. T. 107, figs. 607, 608.

CORONICERAS. Keels prominent, constant; channels well defined. Pilæ tuberculated and bent. Umbilicus open. Sides of the whorls exposed. Pilæ preceded by a line of tubercles in the young, which gradually elongate to form the tuberculated pilæ of the adult. Ventral lobe deep and narrow. Lateral lobes unequally divided. Superior lateral cell irregularly divided; abrupt on the siphonal side; sloping rapidly on the opposite side. Inferior lateral cell exceedingly variable in form, but unequally divided.

Lower Lias.

C. BISULCATUS, d'Orb. T. 103, fig. 557.

ASTEROCERAS. Keel well defined, but varies from prominent and narrow to depressed and broad. Channels obscure to deep and well defined. Pilæ smooth, depressed; often bent on the sides, and appear in the young as lateral folds or large tubercles. Sides in some species not enveloped; in others, covered to fully one-half of their breadth. Ventral lobes very deep. Lateral lobes very shallow. Superior and first auxiliary cells short and broad. Inferior lateral cell very prominent.

Lower Lias.

A. OBTUSUS, Sowb. T. 107, figs. 614, 615.

Family LIPAROCERATIDÆ.

Microceras. Abdomen flattened; sides rounded or flattened. The pilæ in the adult are undivided upon the abdomen, and are continuous with the large, single lateral pilæ, which last may be ornamented with either one or two rows of small tubercles or be bare. The envelopment only covers the abdomen of each internal whorl, reaching no farther than the first row of tubercles; the umbilicus is consequently exposed in all the species. The increase of the radii is slow; the species have a greater number of whorls than in succeeding genera, and are also of smaller size. The septa are remarkable for their unequally divided lobes and cells, the large size of the abdominal lobe, the insignificant size of the two lateral lobes, especially the inferior lateral, and the great breadth of the cells.

Lower and Middle Lias.

M. biferum, Quenst. T. 107, figs. 609, 610.

Androgynoceras. Sides of the adult whorl slope outward and are ornamented with pilæ, usually single and set with two rows of tubercles. Abdomen narrow. The large pilæ of the young are split into smaller pilæ on the abdomen of the adult, but usually retain the characteristics of *Microceras* until a late period of growth. The septa are more complicated than in *Microceras*, and the increase by growth in the radii of the spiral is much greater, the species consequently have fewer whorls and are of larger size. The envelopment may cover up only the abdomen of each internal whorl, or extend over the whole side to the internal line of tubercles.

Middle Lias.

A. hybridum, Hyatt. T. 107, figs. 616, 617.

Liparoceras. This genus differs from both of those previously described in the greater breadth of the abdomen, the greater increase of the radii of the spiral, the consequently smaller number of whorls, and the larger size of the species.

Middle Lias.

L. Henleyi, Sowb. T. 107, fig. 618.

Family DEROCERATIDÆ. (Includes the group Dorsati.)

Deroceras. Whorls circular; pilæ depressed; linear between and bifurcated on the tubercles. Tubercles large, prominent, pointed, and in a single row. Septal lobes with numerous pointed, deeply cut, irregularly shaped minor lobes. Abdominal lobe very deep, and level with superior lateral lobe. Siphonal cell long and narrow.

Lower, Middle and Upper Lias.

D. ZIPHIUS, Ziet. T. 107, fig. 611.

PERONOCERAS. Abdomen depressed; pilæ depressed; linear between the tubercles; usually, but not invariably bifurcated on the abdomen. Tubercles depressed, often obtuse upon the casts, but pointed and prominent upon the shell. Septa not closely crowded, as in *Deroceras*, or so profusely branching.

Middle Lias.

P. MUTICUS, d'Orb. T. 108, figs. 622, 623.

Family THYSANOIDÆ. This family includes the Fimbriati, Ligati, and Heterophylli, which agree in the foliaceous character of the septa.

THYSANOCERAS.* Abdomen rounded; whorls exposed; the envelopment does not extend laterally over more than one-third of each interior whorl. Abdominal lobe about the same depth, but narrower than the superior lateral lobe; the latter is equally divided by a peculiar minor cell of a lobiform aspect. The siphonal cell is cuneiform, and the superior and inferior lateral cells equally divided.

Middle and Upper Lias.

T. FIMBRIATUS, Sowb. T. 101, figs. 538, 539.

RHACOCERAS.† Abdomen rounded; sides of the whorls flattened; envelopment extends over about two-thirds of each of the interior whorls, or entirely encloses them, covering up the umbilicus. The lobes and cells gradually decrease in size inwardly, and are remarkable for the profusion and peculiar foliaceous aspect of the minor cells (= section Heterophylli).

Middle and Upper Lias.

R. HETEROPHYLLUS, Sowb. T. 102, figs. 544, 545.

Professor Meek includes a number of American cretaceous species.

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* Syn. of *Lytoceras*, Suess. Hyatt, Bull. Mus. Comp. Zool., iii, 59.

† Syn. of *Phylloceras*, Suess. *Ibid.*

Family DACTYLOIDÆ. This family includes the Planulati and part of the Macrocephali.

Cœloceras. Pilæ on the abdomen bifurcated; lateral pilæ single or bifurcated with one external row of tubercles, occurring regularly on each pilæ, or at intervals on widely separated pilæ. The young are very much flatter than the adults, and the sides consequently very narrow. They are smooth for the first one or two whorls, subsequently becoming tuberculated. The tubercles almost immediately spread, forming the pilæ; they may enlarge and remain distinct, or become absorbed and disappear upon alternate pilæ. The abdomen remains perfectly smooth for some time after the lateral pilæ are developed, not acquiring the abdominal pilæ until the third whorl is reached. Septa close together and very intricate in the adult. Abdominal lobe broader and deeper than the superior lateral. The inferior lateral is nearly the same in size, and both are unequally divided into three shallow, minor lobes. Superior lateral cell lobiform and together with the inferior lateral, unequally divided by two minor lobes.

Middle and Upper Lias.

C. centaurus, d'Orb. T. 107, figs. 619, 620.

Dactylioceras. The abdomen is either equal in breadth, or less than the back, instead of being broader than, or equal in breadth to, the back, as in the preceding genera. The lateral pilæ in the adult are smooth and invariably single; the abdominal pilæ may be either bifurcated or single. The young have the same development as the young of *Cœloceras crassum*, but the tubercles are dispensed with before the adult state is attained. Septa do not differ materially from those of the preceding genus, except perhaps in the greater simplicity of the lobes and cells, which are hardly so close together or so complicated.

Upper Lias.

D. annulatus, Sowb. T. 102, figs. 540, 541.

Family PHYMATOIDÆ. (Includes part of the Falciferi.)

Phymatoceras. Abdomen may be flattened or rounded, but never acute; has no channels in the adult. Envelopment covers the abdomen of each internal whorl. Radii of the spiral increase more slowly than in the succeeding genera. The young are smooth on the first or second whorl, the tubercles begin on either the second or third whorl, and, gradually dividing, spread themselves out upon the abdomen as bifurcated pilæ, which disappear on the borders of the channels. The keel makes its appearance at an early stage, probably on the second whorl, but the channels are not visible until a much later period, and disappear in the adult. Abdominal lobe broad and deep. Superior lateral broader, but of about the same depth; inferior lateral very shallow. Superior and inferior lateral cells equally divided; both are short, broad, and but slightly indented by the minor lobes.

Middle and Upper Lias.

HAMMATOCERAS. Abdomen may be either rounded or acute, always keeled, but never sulcated. Pilæ are prominent and straight. Envelopment may extend over one-half the sides, or only cover the abdomen of each internal whorl. The young develop as in *Phymatoceras*, but are generally much broader; the pilæ, also, do not become prominent so soon. Nor do they invariably begin by the development of tubercles on the sides, but may make their appearance as fine, raised lines, and afterwards become tuberculated. During the earlier stages of growth the different species have a very close resemblance to the adult Macrocephali. The lobes are more complicated than in *Phymatoceras*. Abdominal lobe broad and deep, and continued into two long, narrow, minor lobes. Superior lateral narrower than the abdominal. Inferior lateral hardly wider than the minor lobes of the superior lateral, and of about the same depth. Abdominal cell blunt. Superior lateral and inferior lateral very narrow and deeply indented by the minor lobes.

Middle and Upper Lias.

H. INSIGNIS, Schloth. T. 108, figs. 624, 625.

PELECOCERAS. Having but one species of this genus, it would be exceedingly hazardous to give the generic characters. They will, however, probably be found to be distinguished by the peculiarly pointed aspect, shallowness and breadth of the lobes and cells; the limits of the envelopment, which last is greater than in other genera of this family; the acute form of the back, and the breadth of the whorls.

Upper Lias.

Family AMALTHEOIDÆ.

PLEUROCERAS. Abdomen flat, with keel and channels well defined; keel crenulated; channels vary from obsolete to deep and well-defined, pilæ swelling below, tuberculated; genicular bend prominent. Tubercles lateral, arranged along the line of envelopment. Umbilicus open. Ventral lobe narrow and but slightly deeper than the lateral lobes; the latter unequally divided. Inferior lateral lobe small, shallow, equally divided. Superior lateral cell only partly exposed on the side, and together with the inferior lateral, unequally divided.

Middle Lias.

PL. SPINATUS, Brug. T. 109, figs. 633, 634.

AMALTHEUS. Abdomen acute, keeled and channeled; whorls compressed laterally. Keel crenulated, well defined. Tubercles, when present, are in a single row along the line of envelopment. Umbilicus open, with the sides of the whorls exposed or only partially covered.

Middle Lias.

A. MARGARITATUS, d'Orb. T. 109, figs. 635, 636.

Family CYCLOCERATIDÆ. This family is remarkable for containing species which on the one side ally it with the Liparoceratidæ, and on the other with the higher Hildoceratidæ. There is, however, a general agreement in the development and in the septal characteristics, which unite them in one family. The form is much more compressed laterally than in the Liparoceratidæ, and the tuberculations of the pilæ separate them from the Hildoceratidæ. The young of *Tropidoceras Actæon* resemble the adults of *Cycloceras Valdani*, and the young of the last in their turn are like the adults of *Platypleuroceras latæcosta;* thus all three genera are closely connected by development. The abdominal lobe is of about the same depth as the superior lateral; the latter is unequally divided into three minor lobes of variable length, and there is only one auxiliary lobe exposed to view on the side. Superior lateral cell is generally equally divided, and of great breadth. Inferior lateral, narrower and more prominent.

PLATYPLEUROCERAS. Abdomen nearly as broad, or broader than the dorsal side of the whorl. Pilæ single, tuberculated, and extending across the rounded abdomen, as in *Planiceras*. The septa are minutely divided by minor lobes, very closely set. The abdominal lobe is deep; sides abrupt. Superior lateral very narrow, deeper than the abdominal, and profusely branching. Inferior lateral not as deep as superior lateral, and of about the same breadth and general aspect. Abdominal cell large and serrated. Superior lateral very broad, about the same height as the inferior lateral.

Middle Lias.

P. LATECOSTATA, Sowb. T. 108, fig. 626.

CYCLOCERAS. Abdomen rounded or keeled, not so broad as the dorsal side of the whorl. Pilæ single, tuberculated, and not extending across the abdomen in the keeled species. Young smooth for the first two or three whorls, then become ribbed. Keel appears at an earlier stage of growth than the pilæ. Septa not so minutely divided by minor lobes, and the larger lobes less dentritic than in *Platypleuroceras*. The abdominal lobe of medium depth and quite broad. Superior lateral of medium breadth and considerable depth. Inferior lateral about two-thirds as broad and deep as superior lateral. One small auxiliary lobe exposed laterally. Superior lateral cell broad and depressed. Inferior lateral more prominent and narrower; small auxiliary cell exposed on the side.

Middle Lias.

C. VALDANI, d'Orb. T. 110, figs. 642, 643.

TROPIDOCERAS. Abdomen invariably keeled, much narrower than the dorsal side of the whorl. Pilæ single, smooth or tuberculated in the same species, do not extend across the abdomen in any species. Young are smooth for one or two whorls. Keel and pilæ appear simultaneously. Septa have a more complicated aspect than in the preceding genus, the minor lobes being deeper and more numerous. The abdominal very broad at the bottom, narrower above. Superior lateral lobe narrow, and about the same depth as the abdominal. Inferior nearly the same, but less branching than the superior lateral. One auxiliary lobe exposed on the side. Abdominal cell very broad. Superior and inferior lateral cells very irregularly divided by minor lobes. One small auxiliary lobe exposed on the side.

Middle Lias.

TROPIDOCERAS ACTÆON, d'Orb. T. 108, figs. 627, 628.

Family HILDOCERATIDÆ. (Includes all the Falciferi proper with smooth pilæ.)

HILDOCERAS. Abdomen keeled and channeled. Ribs large and broad. The young continue smooth throughout the first whorl. Ribs, keel and channels appear on the second whorl. The ribs are not preceded by a line of tubercles, but begin as folds, bent much in the same way as in the adult, but with the abdominal bend inclined more towards the apex. The abdominal lobe is shallow and broad. Superior lateral much deeper than either the abdominal or inferior lateral lobes, the last named very narrow and shallow, minor lobes small and pointed.

Upper Lias.

H. BIFRONS, Brug. T. 103, fig. 556.

GRAMMOCERAS. Abdomen keeled, but not channeled. Whorls flattened laterally, giving a discoidal aspect to the shells. Ribs finer and less prominent than those of *Hildoceras*. The young also continue smooth much longer, and channels never appear; they take, however, the same rounded form of the whorl. Septa differ but slightly from *Hildoceras* in the higher species, and not all generically in the lower species.

Upper Lias.

G. SERPENTINUS, Schloth. T. 103, figs. 558, 559.

LEIOCERAS. Abdomen keeled, acute. Sides of the whorls flattened. Envelopment uniformly greater than in *Grammoceras*. The young differ, however, in being much flatter at the corresponding periods of growth. The lobes and cells, also, are less obtuse, shallower, and much more numerous.

Upper Lias.

LEIOCERAS COMPLANATUS, Brug. T. 110, figs. 644, 645.

Mr. Hyatt has since published the following additional families and genera: I cannot satisfactorily intercalate all of them with the foregoing scheme of classification and have therefore preferred to insert them here, all together.

Family TRACHYCERATIDÆ.

GYMNOTOCERAS, Hyatt. The development of *Ammônites Blakei*, Gabb, and the characters of its abdomen, separate it at once most decidedly from any species of *Trachyceras*. The development generally of a keel, or, in some varieties, of a raised abdomen, over which the pilæ do not pass, shows that this is a different genus, characterized by a different mode of development. The septa are quite similar to those of *Trachyceras*, but it is very evident that in the Trachyceratidæ the septa cannot be looked to for generic differences. Great differences also occur in the amount of involution of the different species and in the development of their external characters.

G. ROTELLIFORME, Meek. Pl. 105, figs. 592, 593. Trias. *Nevada.*

TRACHYCERAS, Laube.

T. WHITNEYI, Gabb. Pl. 105, figs. 590, 591. Trias. *Nevada; California.*

Family PHYSANOIDÆ.

ACROCHORDICERAS, Hyatt. This genus is closely allied to *Lytoceras* and *Phylloceras*, Suess, and *Haploceras* of Zittel, combining characteristics which are found in all of these, besides having peculiar characters of its own, and a different development. The extent of involution is comparable with that of *Haploceras*, but the whorl itself is about intermediate between the extreme roundness of *Lytoceras* and the more flattened sides of *Phylloceras*. Its peculiar characteristics consist in having large lateral tubercles and abdominal pilæ, which are united as they near the tubercles. The smooth zone along the centre of the abdomen in the young is also probably of generic value.

A. HYATTI, Meek. Pl. 106, fig. 594. Trias. *Nevada.*

Genus **EUTOMOCERAS**, Hyatt.

This is a well-marked type, characterized by its lenticular form, narrow umbilicus, apparently at all ages very sharp abdominal keel, without furrows or lateral ridges, and small, regular arched pilæ on middle sized specimens, growing wider, more irregular, less distinct, and developing small lateral lobes on the adult, with both nodes and pilæ becoming obsolete on the larger part of the body-volution.

E. LAUBEI, Meek. Pl. 106, figs. 595, 596. Trias. *Nevada.*

The family relations of the above, as well as of the following genus are not indicated.

Genus **EUDISCOCERAS**, Hyatt.

This type is distinguished by its discoid form, open umbilicus, and an abdominal keel, bordered by furrows and ridges, the latter being interrupted or tubercular; the young with comparatively large pilæ, growing smaller and more flexuous in the adult, and finally fading away in the larger half of the body-volution.

E. Gabbi, Meek. Pl. 106, figs. 597, 598. Trias. *Nevada.*

Family CLYDONITIDÆ, Hyatt. (Includes *Clydonites*, Hauer, and *Coroceras*, Hyatt.)

Coroceras, Hyatt. The species all have numerous lobes and cells, with smooth sutures, and a large abdominal lobe; the latter being very broad and prominent. They are pileately ribbed and very involute; the umbilicus nearly covered. The mouth is more or less hooded or constricted.

C. elliptīcus, Hauer. T. 106, figs. 599, 600. Triassic. *Hallstatt.*

Professor Hyatt remarks that the species included in *Clydonites* form a heterogeneous assemblage of diverse types from which it will be necessary to eliminate other new generic groups.

Family ARIETIDÆ.

Genus Agassiceras, Hyatt. Young quite immature and remarkable for the prolonged existence of the goniatitic form which is generally confined to the earliest stage of growth in the Ammonites. The living chambers are quite short, the abdomen keeled, but not channeled. This genus would not be placed in the group of Arietidæ by many authors. A comparison of the adult with the perfect young of *A. obtusus* shows, however, that both have similar forms and short living chambers.

Agassiceras Scipionianus, d'Orb. T. 108, figs. 629, 630.

Family OXYNOTIDÆ. Young similar to the group of certain aberrant forms of Arietidæ, but the adult instead of the solid keel of Arietidæ possesses a hollow keel. In the old, however, this keel entirely disappears, leaving the abdomen rounded and almost flattened, a transformation entirely distinct from that which occurs in the old of any of the Arietidæ. Here, as elsewhere, however, a single characteristic unites the two; the sutures are similar in both families. The similarities of the young are such as occur commonly between what are supposed to be very widely separated adults in many other distinct families or groups.

Genus Oxynoticeras, Hyatt. Characters those of the family.

Oxynoticeras Guibalianum, d'Orb. T. 111, figs. 653, 654.

To the above must be added the following genera characterized by the late Prof. F. B. Meek:

Genus Mortoniceras, Meek. Shell discoid; periphery with a single, simple, low, central keel, and a more or less defined sulcus on each side of it, the sulci being generally each margined externally by a row of compressed nodes; umbilicus wide; volutions narrow, slightly embracing, and ornamented by regular, simple, straight, tuberculated costæ.

Apparently Cretaceous only (*United States*, *India*); whilst the restricted genus *Ammonites* is probably confined to the lower members of the Jurassic system.

A. vespertinus, Morton = A. Texanus, Roemer. T. 105, fig. 586.

Genus Prionocyclus, Meek. Shell discoid, with more or less depressed periphery having a central keel defined by a concavity on each side; keel at first simple, but at a later period strongly crenate, and in old shells depressed or broken up into a row of elongated nodules; volutions more or less compressed, and but slightly embracing; surface costate and tuberculate; septa with about three lateral lobes on each side, the first of which is longer than the siphonal lobe and tripartite at the end, while the others are much smaller and trifid, or the middle one sometimes bifid; first lateral sinus broad and bilobed, the outer lobe lapping partly on the peripheral side.

Ammonites serrato-carinatus, Meek. Cretaceous. *United States.*

Subgenus Prionotropis, Meek. Shell when very young, with costæ sharply defined, and as the whorls increase in size, becoming more distant, without having the intervening spaces occupied by smaller ones; on the last, the costæ and their nodes become very prominent, the keel depressed and broken into a series of elongated isolated nodes.

P. Woolgari, Mantell. T. 106, figs. 601, 602. Cretaceous. *England*, *United States*.

Professor Meek remarks that the type of the genus so nearly resembles species of Professor Hyatt's genus *Pleuroceras* that were it not for the opinion of Hyatt that none of the Liassic groups range up into the cretaceous, he would not separate them. It would perhaps be much more convenient to continue to regard the various forms of Ammonites simply as sections of a single genus, than to make unlimited and overlapping genera without good characters.

Genus Placenticeras, Meek. Shell with the very narrow periphery truncated, and often provided with a row of compressed alternating nodes along each margin; volutions about three-fourths embraced by the next succeeding outer one; septa with the lateral sinuses provided with more or less branched and digitate terminal divisions; umbilicus small or moderate. Cretaceous. *United States*, *India*.

Ammonites placenta, DeKay. T. 105, fig. 588.

Subgenus Sphenodiscus, Meek. Shell with periphery cuneate; umbilicus very small; volutions each almost entirely embraced by the succeeding one; septa with the first five or six lateral sinuses provided with only a few short, nearly simple, obtuse divisions; while the others are simple, and usually broadly reniform at the ends. Cretaceous. *United States*, *Europe*.

Amm. lobatus, Tuomey.

Meek thinks that some of the species of *Pinacoceras*, Mojsisovics, will fall into this group; and that that genus is too comprehensive.

Neumayr's Classification of Ammonites.

One of the latest systematic arrangements of the Ammoniteæ is that of M. Neumayr, of Vienna.* It is prefixed by an interesting account of his predecessors; Prof. Hyatt's classification

* *Zeitsch. Deutsch. Geol. Gesell.*, xxvii, 854, 1875.

of the Liassic Ammonites receiving scant notice, and his genera not even enumerated because "they do not agree with natural groups."†

The classification appears to be conservative in spirit, and calculated to subserve usefully the needed grouping of the numerous species which overburthen the original genus. The synonymy is unfortunately rendered inextricable by the great difference of opinion as to valid characters entertained by several recent systematists, who appear to have each done their best to increase the prevalent confusion, by forming groups which will not coalesce entirely with those of their contemporaries or predecessors.

The following is an epitome of Neumayr's arrangement:

Family I. ARCESTIDÆ.

Shell smooth or with transverse folds, ribs or striæ; wrinkled layer present in the geologically older forms, consisting mostly of linear, interrupted striæ, seldom (only in *Sageceras*) granular; impressions of the mantle attachment, in the triassic forms, without or with a but slightly contracted opening always visible on the body-chamber. Anaptychus apparently horny in *Arcestes*, certainly present in *Amaltheus*, doubtfully so in the other forms.

Genus **ARCESTES**, Suess. (*ex parte*).

Shell, as a rule, smooth, sculptureless, seldom with longitudinal striæ (Tornati); body-chamber long, taking up one to one and a-half whorls. Whorls strongly involute. Aperture usually contracted by the border being reflected inwards or by internal ridges. Lobes strongly incised (laciniated), so that the saddles merely consist of a slender stem with numerous approximated horizontal branches, which in turn are divided into smaller branchlets.

Many forms have internal nuclei with an open umbilicus, and a terminal whorl with a callous closed umbilicus.

130 species Trias; one species Permian.

ARCESTES TORNATUS, Bronn. T. 108, figs. 631, 632.

† Prof. Hyatt very properly protests against ignoring prior generic names on account of a difference of opinion as to the extent of the groups and the relative importance of the characters given. See *Bost. Soc. Proc.*, xviii, 360, 1876.

Genus **DIDYMITES**, V. Mojs.

External form and length of body-chamber same as in *Arcestes*; shell with sharp lines of growth and plicate wrinkles throughout the whole length of the body-chamber to the aperture; on the inner convex surface of the shell there is a median furrow; the last whorl is constricted near the aperture.

The sutural lines of the septa are formed of few-toothed saddle pairs, which often alternate with single saddles. These saddle pairs, as is shown by projection of the spiral, correspond each to two saddles in the other genera of Ammonites.

Didymites contains but a few triassic forms.

DIDYMITES ANGUSTILOBATUS, Hauer. T. 109, figs. 637, 638.

Genus **LOBITES**, Mojs.

In external form and length of the body-chamber agreeing with *Arcestes* and *Didymites*. Shell usually with transverse folds, which are frequently crossed by fine longitudinal striæ. The body whorl frequently assumes a form very different from the inner ones, and not unfrequently closes the umbilicus with a callus. Towards the aperture, however, and always in those forms with a closed umbilicus, there is a constriction which extends forwards in the form of small, projecting, lateral lobes. The sutural lines of the septa consist of entire margined, high saddles, somewhat contracted at their bases, which vary in height in such a way that the second and fourth are perceptibly lower than would be expected from their position. A high siphonal process.

In many forms there appears, regularly at the end of the body whorl and the one next to it, a portion constricted off the "hood;" in other forms the aperture is simple, and only prolonged anteriorly into lobe-like processes at the convex portions, and but little or not at all constricted.

In *Lobites* the derivation from the goniatitic ancestry is much more striking than in any other mesozoic genus, inasmuch as the form of the lobes is still completely goniatitic. The ammonitic stage is indicated in the structure of the lobes only by the high siphonal process dividing the external lobe.

As palæozoic representatives are to be named: *Gon. clavilobus*, Sandb.; *bilanceolatus*, Sandb.; *bifer.*, Sandb.; *bifer. var. delphinus*, Sandb. Since the lobes of these forms agree in form with those of *Gon. mixolobus*, Phill. and *lunulicosta*, Sandb., Sandberger united both groups under the name of *Lanceolati*. A similar or independently agreeing development of the lobes of distinct, independent races is not unfrequent; a striking example of such a parallel independent development is presented by *Arcestes* and *Pinacoceras*. *Gon. mixolobus* and *lunulicosta*, which differ from *Lobites* in the build of the shell, and present many similarities to *Pinacoceras*, are accordingly, perhaps, to be separated from *Lobites* as an independent generic group.

Nine Triassic species are enumerated.

LOBITES ELLIPTICUS, Hauer. T. 109, figs. 639, 640.
L. DELPHINOCEPHALUS, Hauer. T. 107, fig. 621.

Genus **PTYCHITES**, Mojs.

This genus, also distinguished by its long body-chamber, differs from *Arcestes*, which it most resembles, principally in the structure of the lobes. The external lobe is very shallow and the external saddle remarkably short; the first lateral saddle on the contrary is very high. The saddles are toothed and present indications of the development of branches. The smooth shell is covered with straight or undulating radial folds. *Ptychites* falls into Beyrich's Plicose group and Oppel's Rugifera, and is the ancestral form of *Amaltheus*, as shown by *Amaltheus Suttneri*, discovered by Mr. von Suttner at Munich. Further researches must be awaited before it is possible to decide whether the group *Pinacoceras platyphyllum*, Mojs. and *floridum*, Wulfen, is not to be regarded as a genus descended from *Ptychites* and generically distinct from *Pinacoceras*.

Six species from the Triassic are enumerated.

Genus **PINACOCERAS**, Mojs.

Shell narrow, aperture high, smooth, seldom with knob-like enlargements on the surface. Body-chamber one-half to two-thirds of a whorl long; aperture with short lobular process of the convex portion. Attachment ring commencing a short distance from the aperture and extending to the posterior end of the body-chamber. Impressions of the mantle attachment punctate or striate. Wrinkled layer consisting of broken up striæ. The sutural line of the septa is distinguished by the presence of external adventitious lobes. Three groups of lobes may accordingly be distinguished: 1. The adventitious lobes. 2. The three principal lobes. 3. The auxiliary lobes. The adventitious and auxiliary lobes always present a similar structure, whilst the principal lobes frequently present a peculiar form.

Pinacoceras clearly possesses amongst the *Goniatites* an ancestor in *Gon. multilobatus*, Beyr.

Twelve species from the Triassic.

P. Metternichii, Hauer. T. 103, fig. 564.

Genus **SAGECERAS**, Mojs.

Is close to *Pinacoceras* in the form of the shell and length of the body-chamber, and differs from it in the structure of the wrinkled layer, the form of the lobes and the direction of the lines of growth in the concave portion. The wrinkled layer is coarsely granular, as in *Nautilus*, and does not consist of long striæ and threads, as in the remaining Arcestidæ. The saddles are slender, narrow, tongue-like, entire, the lobes symmetrically divided, simply or doubly, by simple conical teeth. Three groups of lobes, as in *Pinacoceras*. The lines of growth do not trend backwards, as in *Pinacoceras*, but forwards.

Sageceras is already fully developed in the Permian formations, though in these older forms the siphonal process characteristic of the ammonite stage is wanting.

Seven examples from Permian and Triassic.

Sageceras Haidingeri, Hauer. T. 110, figs. 651, 652.

Genus **AMALTHEUS**, Montf.

Siphonal side of the shell sharpened or carinate; ribs when present, absent at this part or broken up into tubercles or folds; the geologically older forms with spiral striæ on the external layer of the shell, which corresponds to the wrinkled layer of the Arcestidæ. Body-chamber short, one-half to two-thirds of a whorl long; margin of aperture simply emarginate, with long, external processes, ending in spoon-shaped extremities, sometimes bent outwards or inwards. A simple, corneous anaptychus. Lobes usually strongly incised, siphonal lobe shorter than the first lateral, lobular bodies broadly wedge-shape.

The development of the Amaltheæ in the older formations has already been spoken of by Waagen, and we will here only add certain observations on their structural peculiarities, which the genus acquires in the cretaceous times. On one side we find forms in which the lobes are arranged in the normal way, so that after the siphonal lobe, two lateral, and finally several auxiliary lobes succeed each other; one portion of these species is furnished with very complicated lobes, whilst in others reduction occurs (*Am. Requienianus*), which may go so far as to form ceratiloid lobes (*Am. Robini*, Thioll., etc.). On the other hand, forms appear in the chalk which differ entirely from the normal law of the arrangement of the lobes, inasmuch as five lobes may intervene between the siphonal lobe on one of the flanks of the whorl to the sutural line. In order to understand this structure, one must remember that in many Jurassic Amaltheæ the lobular bodies are already become short and broad, so that the three long, slender, terminal branches of the first lateral have attained a certain degree of independence; besides the external saddle becomes very broad, so that the secondary lobe at its base stands out strongly. Most instructive of all, in regard to the transition of this arrangement to the complete independence and equivalence of all these elements and the complete disappearance of the body of the first lateral lobe, is the arrangement of the sutures in the form from the North German Neocomian, which is cited as *Am. Gervillianus*, and in *Am. Balduri*, Keys.

Of these cretaceous Amaltheæ with abnormal arrangement of the lobes, there are two groups, viz.: the one has lobes much toothed, and here belong *Am. syrtalis*, Mort., *placenta*, Dek., and their allies; the other presents atavistic reduction of the lobes, which have here also progressed as far as the ceratitic stage (*Am. pedernalis*, Roem., *vibrayeanus*, d'Orb.).

All cretaceous *Ammonites* with an abnormal number of lobes belong to *Amaltheus*, as well as the greater part of the cretaceous *Ceratites*, of which, however, a smaller portion do not belong here but to *Schloenbachia*.

Sixty-eight species enumerated; Triassic, Jurassic and Cretaceous.

Amaltheus margaritatus, d'Orb. T. 109, figs. 635, 636.

Genus **SCHLOENBACHIA**, Neumayr.

This genus embraces the very natural group of Cristati; to these I add the *Schl. Germari*, Reuss., whose affinity to these is indicated besides other striking characters, by a toothed keel.

The characters of *Schloenbachia* may be stated as follows: Shell strongly keeled, usually with strong ribs curved forwards on the flanks; body-chamber two-thirds of a whorl long, drawn out at the sickle-shaped aperture into a long, beak-like process, which is either prolonged in conformity with the curvature of the spiral or bent outwards. Siphon very stout, usually lying in the keel, which is often cut off from the lumen of the shell by a calcareous septum. Lobes not much branched, with bodies which are narrower than the saddles; only one distinct auxiliary lobe; which is wanting in some forms. Siphonal lobe usually as long or longer than the first lateral. In some species a great reduction in the number of branches of the lobes takes place, so that they approach a Ceratitic form. (*Schl. senequeri* and *halophylla.*)

Forty-six species.

Schloenbachia cristata, Deluc. T. 103, fig. 560.

Family II. TROPITIDÆ.

Shell more or less richly ornamented, provided with radial ribs, which almost always support on the edge of the convex portion (frequently also on the sides) knobs and spinous processes. Wrinkled layer and impressions of the mantle attachments entirely absent.

Genus **TROPITES**, Mojs.

Body-chamber long, embracing one and three-quarters to one and one-half whorls. The strong sculpture is interrupted on the convex portion of the shell; frequently a median keel is present on the same. At the aperture the convex portion is prolonged into a broad, short lobe. The last whorl frequently differs in form and sculpture from the inner whorls. The lobes are distinguished by their broad saddle stalks, with divisions cut in obliquely, the oblique position of the tips of the lobes, great development of the principal lobes, and striking reduction of auxiliary ones.

Eleven Triassic species.

TROPITES RAMSAUERI, Quenst. T. 111, figs. 655–657.

Genus **TRACHYCERAS**, Laube.

Body-chamber short, one-half to two-thirds of a whorl long. The sculpture on the convex portion is interrupted; in the geologically younger forms a more or less deep median furrow is sunken in, at which the ribs terminate in a tubercle. Aperture with a short lobate process on the convex portion. Lobes agreeing with *Tropites;* much simpler in the geologically older forms.

Sixteen Triassic species.

TRACHYCERAS BICRENATUS, Hauer. T. 109, figs. 641, 642.

Genus **CHORISTOCERAS**, Hauer.

From *Trachyceras* a group branches off, distinguished by a larger growth and simple or slightly toothed lobes, with a short body-chamber, in which, on the inner whorls the median interruption of the sculpture on the convex portion is almost always visible, whilst on the outer whorls the ribs are continuous over the convex portion. It is also to be observed that on one hand the lobes exhibit the persistence of an ancient stage of development, and on the other a special variation from the sculpture of the *Trachyceras* type.

Nine Triassic species.

Genus **RHABDOCERAS**, Hauer.

Rod-like, elongated forms with oblique annular sculpture and simple curved lobes; still very imperfectly known, and are, according to all probability, to be placed next to *Choristoceras.*

RHABDOCERAS SUESSII, Hauer. T. 100, figs. 513, 514.

Genus **COCHLOCERAS**, Hauer.

The whorls are spirally coiled to the left, with continuous ribs and simple curved lobes. This form also may be placed next to *Choristoceras.*

COCHLOCERAS FISCHERI, Hauer. T. 100, figs. 518, 519.

Family III. LYTOCERATIDÆ.

To this family we assign the monophyllic genera *Lytoceras* and *Phylloceras*, and those evolute or straight forms allied to the first, *Baculites*, *Hamites* and *Turrilites*; they are characterized by a short body-chamber (two-thirds of a whorl) and a simple aperture; in all other characters such a marked differentiation takes place, that it is scarcely possible to find one which is common to all, so complete also are their interrelations in a genetic aspect. The simplicity of the aperture is itself not found constant in the Baculites.

There is no instance recorded of the presence of an aptychus in a form belonging to this group; there is also no positive evidence on the ground of such negative observations that it is wanting, but it is in the highest degree probable, at least in respect to the geologically older forms.

Genus **LYTOCERAS**, Suess.

Shell flattened, discoidal, whorls but little involute or simply in contact; body-chamber two-thirds of a whorl, margin of aperture at the columellar side produced into a lobe, processes wanting at the siphonal side and on the flanks; lines of growth and sculpture parallel to the margin of the aperture, at the suture bent forwards; sculpture feeble, mostly consisting of radial lines or interruptions; sutural line with few lobes, lateral lobes and saddles symmetrically divided, columellar lobe two-pointed. No aptychus.

The forms of the Trias diverge herefrom in such a way, that in them the lines of growth and sculpture, as in *Phylloceras*, are directed forward at the siphonal side, and that the structure of the saddles is monophyllic.

Sixty-two species, from the Trias, Jura and Cretaceous.

LYTOCERAS HENLEYI, Sowb. T. 107, fig. 618.

LYTOCERAS MORELETI, Hauer. T. 110, figs. 646, 647.

Genus **HAMITES**, Park.

In the classification of the evolute cretaceous Ammonites, the form of the spiral has until now been available or used as a distinguishing characteristic, and, as observed above, has led to the establishment of a superabundance of genera; after careful trial I believe that the following may be included in Hamites:

Anisoceras, *Ancyloceras*,* *Baculina*,* *Hamulina*, *Helicoceras*, *Ptychoceras*, *Toxoceras*.

The principal reason why I am necessitated to suppress these genera, is this: that in their characterization, only the characters prevalent in the species of the series belonging here are used, a proceeding by which, of course, a completely unnatural subdivision is effected. In the departure from the closed spiral, a new direction of variation is assumed, and one is therefore entirely justified in making a division here from the old stems; for farther subdivision, on the contrary, we must adopt few or no characters derived from the tendency of variation. The sculpture is here hardly available, and indeed hardly at all in the beginning of the series of evolute forms, but perhaps in the farther stages, where an abnormal development and strengthening of ornamentation tends to take place. In this respect, the lobes will best serve our purpose, since we find amongst evolute forms a great number which present exactly the symmetrical structure of the lobes of *Lytoceras*, whilst the others have equally distinct unsymmetrically divided lobes and saddles.

Amongst the forms which present symmetrically divided lobular structure, are some, the geologically oldest, which also exhibit such striking agreement with *Lytoceras*, that there can be no doubt that these have descended from representatives of that genus. Aside from the relations of the whorls, all other characteristics of *Scaphites Yvanii*, further of *Crioceras Astierianum* and *depressum*, these agree most completely with cretaceous *Lytoceratidæ*, the first with *L. rectecostatum*, the last with the group of *Lyt. Timotheanum*. By simple continuous development of the spiral in the direction of variation, and of course progressing quite in the normal way from without inwards, we obtain from *Scaphites Yvanii* the genus *Hamites*, from which *Ptychoceras* differs only in the most subordinate characters. The imperfectly known genus *Anisoceras* may also be most appro-

* The cretaceous forms of *Ancyloceras* and *Baculina* must be embodied into other genera, though one could easily transfer their names to forms from the middle Jurassic, for which otherwise new names would have to be coined (*Ancyloceras calloviense* and *annulatum*, *Baculina œnaria*).

priately placed here, the characters of which, aside from the mode of curvature. ally it to *Hamites*, the slight distortion of the shell not justifying an independent genus. That an independent genus cannot be established for these forms, is certain, and doubt only exists as to whether they should be referred to *Hamites* or *Turrilites*, a question which can only be definitely decided when the shells are more accurately and completely known.

With the change in the spiral, a change often takes place in the sculpture, which is often distinctly strengthened; this is however, not the case with the commencement of the series of forms, but occurs somewhat later, some time after the separation from the involute ancestral form.

A character which appears with remarkable constancy in the involute *Lytoceratidæ* is gradually lost in their evolute successors, namely, the two-pointed ending of the antisiphonal lobe. In some of these this part is retained, as is shown in part by existing figures, and partly as I have learned from a study of the Pictet Collection, this is the case in *Crioceras depressum*, *Ancyloceras alternatum*, *saussureanum*, *pseudoelegans*, *Hamites bouchardiamus*, *alterno-tuberculatus*, *elegans*. In many others, however, a one-pointed structure steps in, and I could convince myself that this occurred by one point uniting with the other: it is very apparent in forms which are derived from the spiral in one plane that a distortion takes place, although a one-pointed antisiphonal appears also in forms in which the spiral is in one plane, even though from the minuteness of this character I could not unqualifiedly admit this in respect to all the species which are figured in this manner.

For the forms here named one genus is quite sufficient, and we choose, for evident reasons, the oldest name, *Hamites*. Relative to the other cretaceous Ammonites, compare below on *Turrilites*, *Baculites*, *Scaphites* and *Crioceras*.

In the lowest cretaceous strata (Berrias) we find no *Hamites*, and in general no evolute *Ammonites;* the oldest representative may be considered to be *H. Yvanii*, from the appearance of which the genus extends through the whole cretaceous; they seem to reach their maximum of development in the gault.

Hamites is certainly not a monophyletic genus; whilst the majority of the forms stand in closest relationship to *Hamites*

Yvanii of the lower Neocomian, there is another group, that of *Hamites* (*Crioceras*) *Astierianus* and *depressus*, of much younger origin, which is most intimately allied to *Lytoceras Timotheanum* from the gault.

The character of the genus may be defined somewhat in the following manner: *Lytoceratidæ*, in which all the whorls or a part are not in contact; spiral coiled in one plane, or exserted for only a small part of its course; upper lateral lobe always, lower mostly, divided into paired branches.

Over 100 species.

Genus **TURRILITES**, Lamarck.

The great majority of cretaceous Ammonites not coiled in one plane, which are divided into the genera *Turrilites*, *Helicoceras* and *Heteroceras*, manifest by the symmetrical division of the lateral lobes decided affinities with *Lytoceras* and *Hamites;* besides, the forms least divergent from the forms with the spiral in one plane, which are referred to *Helicoceras*, also present in all other characteristics such a striking agreement with *Hamites*, that their incorporation with that genus is undoubtedly correct. On the other hand the extreme forms diverge widely from this type, and a new direction of variation is presented, so that full justification exists for regarding them as generically distinct.

The new direction of variation which makes itself apparent in the *Turrilites*, consists in the divergence from the plane in one coil, and the gradual development of a spire-shaped shell; since *Helicoceras* in the various grades of its divergence from *Hamites* only represents the various stages on this line, this genus must be included, as Pictet had already indicated. Finally, *Heteroceras polyplocum* and *Reussianum* represent only somewhat abnormal forms of development of the same type.

We cannot, however, here place all the cretaceous Ammonites which diverge from the spiral in one plane; in the upper Neocomian a very singular form appears, and as far as is known, diverges widely from all other forms, and which is also not coiled in one plane, but which is distinguished by an asymmetrical development of the lateral lobes, namely: *Heteroceras Emericianum*, Orb., *Astierianum*, Orb., and *bifurcatum*, Orb., which we will place as *Heteroceras* in the genus *Crioceras* below.

Turrilites Senequierianus. Orb., is also to be referred there, which is distinguished by its habits from all other Turrilites, and approaching very closely the earlier whorls of *Heteroceras*, with which also, according to Pictet, it has in common the unsymmetrical build of the lateral lobes. Possibly *T. Senequierianus* is only the young of what in the adult state is a *Heteroceras* provided with an irregular shaft or body, as Pictet has already considered it.

Fifty-one species.

Genus **BACULITES**, Lamarck.

The completely straight Ammonites of the cretaceous have been embraced in the genus *Baculites* and form a very good natural group, which in the structure of the first lateral lobe is allied to *Lytoceras* and *Hamites*: in fact, between a *Hamites* with two straight limbs and a *Baculites* there is no important difference. A list of species of *Baculites* and a repetition of the diagnosis of the genus would be superfluous, as no change is here made.

Genus **PHYLLOCERAS**, Suess.

Shell discoidal, involute, with feeble sculpture, sometimes with constrictions or varices, lines of growth directed forwards; body-chamber short, margin of aperture simple with somewhat produced lobes on the external side; no aptychus; lobes numerous, diminishing regularly in size, laterals without subdivision into principal paired branches; leaves or lobes of the saddles very much rounded; antisiphonal lobe two-pointed.

The Phylloceratidæ branch off, according to von Mojsisovics, from stems of the monophyllic Lytoceratidæ of the Trias: the geologically oldest forms are still distinguished by few lobes and a somewhat wider umbilicus. Within the limits of certain series of forms a very constant direction of variation becomes apparent in such a way that a steadily progressive complication and increase in the number of saddle lobes or leaves takes place.

The genus fully retains the type in the cretaceous which it assumed in the Jurassic, so that a doubt as to their position can never arise; namely, a reduction and simplification of the lobular line never takes place, which would seem to indicate an affinity here to the cretaceous *Ceratites*, as has been thought by some authors and as I have myself assumed; but there may be question of the accuracy of this reference, as the latter belong to the Amaltheæ. Relative to the cretaceous Phylloceratidæ it is to be observed, that a large part of the forms described by d'Orbigny were founded on young specimens, which had not yet developed the specific characters and which must therefore be withdrawn. In regard to some of the Indian forms described as Heterophylli by Stoliczka, I am not certain that they belong to *Phylloceras* on account of the imperfect representation of the lobes; in the hot climate of India the oily layer with which the lithographic rocks are covered always becomes somewhat softened, so that the more minute details are often lost.

Seventy-seven species; Trias, Jura, Cretaceous.

PHYL. OCCULTUM, Mojs. T. 110, figs. 648, 649.

Family IV. ÆGOCERATIDÆ.

The forms, which can be traced from *Ægoceras*, present such manifold characteristics, it is not possible to even offer one positive character, with the exception of the attached cover of the nidamental gland, which indeed, has been observed only in a limited number of species, but in forms belonging to most of the included groups. All the forms also, which we know, have the lobes toothed all around, but by which, to be sure, the possibility of the existence of a stem form with simple sutures is not excluded.

The geologically oldest forms are those of the Muschelkalk, the affinity of which with those of the Lias Beyrich was the first to apprehend; they are absent in the upper Trias in almost all the yet known localities and again appear first in the uppermost strata in *Ægoceras planorboides*. At the beginning of the Jurassic they attain an extraordinary development, the details of which will be described.

From the great extent of the family it is perhaps better to subdivide them in the following manner:

1. ÆGOCERATINÆ:—*Ægoceras*, *Arietites*.
2. HARPOCERATINÆ:—*Harpoceras*, *Oppelia*, *Haploceras*.
3. STEPHANOCERATINÆ:—*Stephanoceras*, *Cosmoceras*, *Ancyloceras*, *Baculina*, *Simoceras*, *Perisphinctes*, *Olcostephanus*, *Sca-*

phites, *Hoplites*, *Acanthoceras*, *Stoliczkaia*, *Crioceras*, *Heteroceras*, *Peltoceras*, *Aspidoceras*.

Genus **ÆGOCERAS**, Waagen.

Shell mostly compressed, composed of many whorls, embracing but little, sometimes provided with nodose or externally bifurcate ribs; never with true sickle-like ribs; not carinate; body-chamber usually a whorl long, in the geologically younger forms somewhat shorter. Aperture simple without lateral appendages, with very weak external lobes and a constriction; a single corneous aptychus. Lobular line strongly notched, upper lateral longer than the siphonal, lower lateral not always present; usually with a depending siphonal lobe. Lobular bodies narrow, not wedge-shaped; antisiphonal two-pointed.

Several series of forms may be defined, upon the proper reference of which further investigations remain to be made; one of these is that of *Æg. incultum*, Beyr., to which *Æg. palmai*, Mojs., *Buonarottii*, Mojs., *planorbis*, Sow., *Johnstoni*, Sow., *planorboides*, Sow., etc., are related; a second series belongs to *Æg. subangulare*, Oppel., *angulatum*, Schl., *Charmassei*, Orb., *marmoreum*, Opp., and allies; a third is formed by the typical Capricorns and Armata, from which *Stephanoceras* with *Ægoceras* or *Stephanoceras pettos* and *Davoei* have developed; a fourth, going back to the preceding series is represented by the Falcoida which stand on the border towards *Harpoceras*. *Æg. taylori*, *Henleyi*, *alternum*, Opp., are somewhat aberrant forms, the inner whorls of which indicate their affinity to *Ægoceras*.

The true *Ægoceras* died out in the middle Lias.

Four Cretaceous, fifty-four Liassic species.

ÆGOCERAS BIFERUM, Quenst. T. 107, figs. 609, 610.

Genus **ARIETITES**, Waagen.

Shell flat, discoidal, with wide umbilicus; on the flanks simple straight ribs, those on the external angle often angular or in curves directed forwards, frequently spinose. External side carinate, often with two furrows at the sides of the keel. Margin of aperture simple, straight at the flanks, produced into a pretty long, pointed lobe, which is never bent inwards; body-chamber embracing one to one and a-quarter whorls.

Siphonal lobe almost as deep as wide; the point of attachment to the siphon is exactly in the middle of its depth; the upper lateral does not attain half of its depth and is at least as broad as deep; the lateral saddle is more elevated than all the others and stands above the base of the upper lateral usually double as high as the external saddle; the lower lateral lobe is much broader than deep and the antisiphonal saddle so small, that it does not attain half the height and width of the lateral saddle. Antisiphonal lobe two-pointed. Corneous, simple anaptychus.

Waagen says that the separation of *Arietites* and *Ægoceras* is difficult, and Hyatt observes that a genetic interrelationship exists between the two. The first representatives appear in the lowermost Lias, and according to our present understanding of the genus they appear to have died out in the lower Lias, though many forms appear, which at present referred to *Harpoceras*, in reality belong to Arietites, as, for example, *Harp. Algoviamum.*

Thirty-eight species.

Arietites Ophidioides, Orb. T. 107, figs. 607, 608.
" Scipionianus, Orb. T. 108, figs. 629, 630.
" obtusus, Sowb. T. 107, figs. 614, 615.
" Kridion, Orb. T. 106, figs. 605, 606.
" bisulcatus, Brong. T. 103, fig. 557.

Genus **HARPOCERAS**, Waagen.

External form of the shell variable, external side always carinate or angular; sculpture consisting of more or less distinct sickle-like ribs. Margin of aperture sickle-shaped, or with ears, with pointed external lobes; body-chamber embracing one-half to two-thirds of a whorl, carinate to the margin of the aperture. Aptychus divided, thin, calcareous, with a thick, shelly layer, more or less folded.

Lobes mostly not deeply notched, always two lateral lobes and almost always auxiliaries. Siphonal lobes ending in two diverging branches, usually shorter than the first lateral; laterals not divided into symmetrical halves.

Sharp demarkation from the genus *Ægoceras* is wanting, since the forms from the group including *Æg. arietiforme*, Opp., fit as well into the one as into the other; the most recent *Harpoceras* is *Harp. Zio* from the upper Kimmeridgian. The present genus still needs revision, since no doubt some of the geologically younger *Arietites* have been improperly included here. Another point, which needs farther investigation, is the relation of many forms to the group of *Æg. angulatum*, Schloth.

Ninety-six species.

HARPOCERAS ACTÆON, d'Orb. T. 108, figs. 627, 628.
" BIFRENS, Brug. T. 103, fig. 556.
" SERPENTINUM, Schl. T. 103, figs. 558, 559.

Genus OPPELIA, Waagen.

Shell with umbilicus usually narrow, external side either rounded only on the body-chamber or on all the whorls. Sculpture sickle-shaped, body-chamber frequently geniculate, never carinate or angular, embracing one-half to two-thirds of a whorl; margin of aperture sickle-shaped or with ears, always with rounded external lobes. Siphon stout with calcareous sheath. Aptychus divided, calcareous, thick, folded (*Apt. lamellosus*); muscles of attachment near the margin in the lower half of the shell. Lobes moderately branched, siphonal mostly shorter than the first lateral; lobular bodies slender with almost parallel edges; lateral lobes divided into two principal symmetrical branches.

Oppelia branches off in the lower Oolite with *Opp. subradiata* from *Harpoceras;* the last representatives, as far as we know, appear in the upper Jura of Stramberg, where a considerable number of different forms are found.

Seventy-one species.

OPPELIA SUBRADIATA, Sowb. T. 110, fig. 650.

Genus HAPLOCERAS, Zittel.

The genus *Haploceras* was established by Zittel for a group allied to *Oppelia* from the middle and upper Jurassic, which is characterized by very feeble or no sculpture; also some cretaceous forms, as *Hapl. Grusanum* are placed here; and with them forms very pronounced wedge- or chisel-shaped in section, as *Hapl. belus*; finally, species with quite sharp external sides, as *Hapl. nisus*, Orb.

In other Jurassic species of *Haploceras*, there is gradually developed a transverse sculpture. which is confined to the external side of the body-chamber (*Hapl. jungens*, Neum., *carachtheis*, Zeuschner).

In certain upper Jurassic forms, which are allied to *Hapl. carachtheis*, the sculpture gradually passes from the external side over to the flanks in feebly undulating ribs, as is shown in *Hapl. cristiferum*, Zitt.; better developed in *Hapl. wöhleri*, Opp.; and this feature is repeated in *Hapl. difficile*, Orb., *Cleon*, Orb., *bicurvatum*, Leym.

Finally, species of *Haploceras* appear which are distributed in the Cretaceous, with constrictions reaching forwards (*Hapl. Beudanti*, *Parraudieri*), a peculiarity with which I have not met in any Jurassic form; the inner whorls here serve as sure guides, aside from the agreement of the lobular markings, since they represent a typical *Haploceras* with entirely smooth whorls. With these furrows a sickle-shaped undulating radial sculpture is gradually combined, and a group of forms results, of which the principal type is *Hapl. planulatum*, Sow.

In spite of this great manifoldness, it is very easy to distinguish the representatives of *Haploceras* from strata which are lower than the Turonian and downwards, by their whole habitus and lobes, yet nothing is more difficult to express in words.

The number of lobes in *Haploceras* varies, since besides the siphonal lobe and the two laterals two to four auxiliaries are present; the lateral lobes are never symmetrically divided (a difference from *Lytoceras*), and never present the characteristic rounding of the saddle lobes of *Phylloceras*; in the forms from the Neocomian the lobes are not yet very complicated, but later are much branched, with slender stems; the stems of lobes mostly broader than those of the saddles, the first lateral not strikingly larger than the second.

If we compare the lobes of other forms, *Schloenbachia*, *Amaltheus*, *Phylloceras*, *Lytoceras* and *Acanthoceras* are excluded from consideration; a difficulty can only arise in regard to *Hoplites*, which certain forms resemble in their lobular structure. Only here the width of the lobes and bodies of the saddles will seldom allow of a remaining doubt, since the latter are, as a rule, broader than in the first, the strong development of the external saddle, the striking difference in size between the two laterals, finally the broader, better rounded forms of the lobes of the saddle in *Hoplites* will almost always clear up all remaining doubts.

The general habit, which in most Haploceratites is easily understood, it is scarcely possible to put into words, though I will attempt in this relation to lay down some principles. A large part of the forms is characterized by sickle-shaped furrows, which, besides are found only in the genera *Lytoceras* and *Phylloceras*, which are fundamentally different in their lobular markings; thin ribs, which are undivided and straight are also confined to these genera. Regular and distinct division of the ribs is never found in *Haploceras*. Slender, undivided, widely separated ribs, hardly ever exceeding ten in number on one whorl, are found only in *Haploceras* and in *Lytoceras*, which is easily distinguished by its lobes. Also the alternation of strong ribs with numerous finer ones, which are placed between the coarser; a prominent carina or a broad furrow are not present on the external side.

To define a genus in this way, may be considered very unprecise and unscientific; a proceeding hardly possible in any other department of conchology, unless in the specimens under examination the most important parts are wanting; in spite of this meagre diagnosis, the species of *Haploceras* are however very easily distinguished from their cotemporaries.

The characters named up to this point are confined to the geologically older forms; a very peculiar development is assumed by *Haploceras* in the upper strata of the cretaceous, in the Turonian and Senonian, where they become developed into the enormous giant forms of the group of the *Hapl. peramplum*; appearing at first as though not belonging here, but the agreement in the lobes and inner whorls leaves little doubt that they are to be here referred; they are easily distinguished from all other upper cretaceous forms by the lobes.

Seventy-six species. Jura, Cretaceous.

Haploceras ligatum, d'Orb. T. 102, figs. 542, 543.

Genus STEPHANOCERAS, Waagen.

General form of the shell very variable, external side rounded without keel, angle or furrow. Sculpture never sickle-shaped, decorated with straight, bifurcating ribs, abundantly provided with nodes or swellings. Margin of aperture simple or with ears mostly formed of a broad, smooth zone; aperture frequently constricted. Body-chamber one to one and a-quarter whorls long. Aptychus divided, calcareous, very thin, covered with granules on the external surface. Lobes usually deeply divided, siphonal and upper lateral lobe usually of the same length; a stout auxiliary sutural lobe; lobular bodies narrow.

Stephanoceras diverges from *Ægoceras* with *Steph. pettos* in the middle Lias; according to the subdivision into groups, it embraces the Liassic Planulata, Coronata and Bullata after the exclusion of some heterogeneous elements; the last representatives come from the Oxfordian (*Steph. Collini*, Opp , *glomus*, Opp.).

For the forms with contracted aperture, and constricted, sometimes geniculate body-chamber, the name *Protophites*, Ebray, exists, though it appears to me that this separation is not yet well enough established.

Forty-one Jurassic species.

S. ANNULATUM, Sowb. T. 102, figs. 540, 541.
S. BLAGDENI, Sowb. T. 102, figs. 550, 551.

Genus **COSMOCERAS**, Waagen.

Siphonal side mostly with a smooth furrow; sculpture consisting mostly of dividing ribs, directed forwards at the siphonal side, frequently ornamented with nodes or swellings; margin of aperture in the young state frequently with ears, which are lost by age; body-chamber one-half whorl long. Lobes moderately divided; siphonal lobe distinctly shorter than the first lateral; second lateral repeating the form of the first; one or more auxiliaries. Aptychus apparently as in *Stephanoceras*.

In respect to the limits of this genus, I differ very much from those originally assigned it by Waagen, since I on one hand exclude all the cretaceous forms except *Cosm. verrucosum*, and on the other include the Parkinsonia; for the first change the motive may be found in *Hoplites* above; the last seems to me necessitated by this, that the whole genus, in our present comprehension of it, is a complete series of forms, which, with the appearance of the siphonal furrow and development of the sculpture, enters upon a line of variation diverging from *Stephano-*

ceras, which seems to be completed in the Parkinsonia. In respect to the genetic relationship with the Parkinsonia, the inner whorls of the Runcinata are above all decisive, which, as is well known, possess the characters of the *Parkinsonia*.

I place here provisionally, the small group of *Macrocephala*, the affinities of which await more thorough investigation ; on the one hand their reference to *Cosmoceras* is indicated by the remarkable resemblance of the last whorls of *Cosm. Gallilaeii*, while on the other the inner whorls of the *Macrocephala* present no trace of the siphonal furrow, and also in form and ribbing much analogy exists with inflated species of *Stephanoceras* with narrow umbilicus. The *Macrocephala* are strangers in the European Jurassic fauna, which, in our part of the world appears only for a short time; when we have learned to know more accurately their ancestral limits, only then will a distinction be possible, and probably it will be necessary to establish a distinct genus for their reception. Preliminarily I will regard them as *Cosmoceras*.

Forty-two species.

COSMOCERAS CALLOVIENSE, d'Orb. T. 111, figs. 660, 661. Jurassic.

Genus **ANCYLOCERAS**, d'Orb.

In the middle Jurassic a number of evolute forms appear. which so fully agree in sculpture and lobular structure with their cotemporary *Cosmoceras*, that we must, according to the precedent of Quenstedt, regard them as forms of that genus which have become evolute. Strictly considered, one could propose a new name for them, but to avoid this, it appears to the purpose to adopt the name *Ancyloceras*, which has become vacant amongst the cretaceous Ammonites since they have been hitherto placed in this genus. The quite smooth initial whorls are very striking, a character which also appears in *Cosm. verrucosum*.

Genus **BACULINA**, d'Orb.

In the Suabian *Ornata* clays, an entirely smooth and straight form of Ammonite appears, which, at the first glance, seems quite enigmatical and of uncertain reference. If, however, the smooth initial whorls of the middle Jurassic *Ancyloceras* are compared with *Baculina acuaria*, we find that aside from the curvature, it agrees entirely with the former, that we must regard this sculptureless rod, strange as it may seem, as one of the *Ornata* much elongated; in regard to this agreement with the initial whorls of *Ancyloceras*, Quenstedt had already noticed it. From *Baculites*, *Baculina* is distinguished by one-pointed lateral lobes. In order to avoid making a new name, *Baculina* may be here applied.

BACULINA ARCUARIA, Quenst. T. 100, fig. 517.

Genus **PERISPHINCTES**, Waagen.

Shell mostly with wide umbilicus, with rounded external side, sculpture consisting mostly of straight, undivided, not nodose ribs; margin of aperture simple or with ears, with a constriction; also isolated constrictions on the inner whorls. Length of body-chamber two-thirds to one whorl, mostly scarcely embracing one circumference or turn. Lobular line similar to *Stephanoceras*, usually somewhat more deeply notched, with a dependent sutural lobe. Aptychus divided, calcareous, very thin, externally granular.

The genus *Perisphinctes* embraces the old group of the *Planulata*, with the exclusion of the Liassic forms, which belong to *Stephanoceras;* the geologically oldest species of typical *Perisphinctes* is *P. Martinsi*, from the upper part of the Lower Oolite; the genus branches off in all probability from *Stephanoceras*, but the relationship between the two is however not yet fully known. The maximum development is reached in the upper Jurassic; in the Cretaceous there are yet few representatives which have retained their character in purity, and instead numerous diverging series branch off, which must be separated as distinct genera, and which embrace the majority of the cretaceous Ammonites.

We here place also another group provisionally, which perhaps deserves to be elevated into a distinct genus. To *Perisphinctes fraudator*, Zitt., from Stramberg, which still presents the type of the genus some Stramberg forms are allied with a deepened, smooth external furrow and stronger sculpture on the body-chamber, as *Per. microcanthus*, Opp., *Köllikeri*, Opp., *symbolus*, Opp. To these certain forms from the lower Neocomian are allied, which, differing little amongst themselves, become more and more distinct in their sculpture from the ground form, approaching the group *Per. radiatus;* these intermediate forms, whose inner whorls still present the true characters of Perisphinctæ, are *Per. Chaperi*, Pict., *Enthymi*, Pict., *Malbosi*, Pict. The most extreme form of the whole series is *Per. Leopoldianus*, which in the young state agrees closely with *Per. radiatus*, but becomes quite smooth in old age; hand in hand with the change in the sculpture, a modification in the lobular markings also steps in.

I have not been able, as yet, to resolve upon the generic separation of these forms from *Perisphinctes*, since the range of variation of the forms is so very small, and only becomes somewhat greater in two forms, viz: in *Per. radiatus*, Brug., and *Leopoldianus*, d'Orb.

It is remarkable that *Perisphinctes Leopoldianus* bears much resemblance to *Haploceras Beudanti* in the form of the lobes; but according to the form of the inner whorls, *Hapl. Beudanti* undoubtedly does not belong to the forms derived from *Perisphinctes*.

161 species. Jurassic, Cretaceous.

PERISPHINCTES ARBUSTIGERUS, d'Orb. T. 112, figs. 662, 663. Jurassic.

Genus **OLCOSTEPHANUS**, Neum.

The best known typical species of this genus, *Olc. astierianus*, was placed in *Perisphinctes* by Waagen, and, in fact, it, with its numerous relatives, belongs to this stem; I believe, however, it should be separated from the genus *Perisphinctes*, since it forms a very well marked divergent series, and differs in several important characters from the typical representatives of the latter.

The origin of the group of forms which we embrace under *Olcostephanus*, is not to be sought in Europe, but the divergence from *Perisphinctes* seems to have taken place far in the East, and after completed differentiation of the type, migrated into European districts. The intermediate form between *Perisphinctes* and *Olcostephanus* is represented by *Olc. Cautleyi*, Opp., from the Indian Jurassic, which shows the point of bifurcation of the ribs pushed in to the umbilical angle, but which in other respects presents the characters of *Perisphinctes;* then to this form *Olc. Stanleyi*, Opp. and *Groteanus*, Opp., from India, are allied, the last of which is also found in Stramberg as the oldest representative of its genus in Europe; and this form stands so near *Olc. astierianus* that it was at first directly identified with it by Pictet. The forms allied then to *Olc. astierianus*, from the European Neocomian, are to be placed here.

To *Olc. astierianus*, the group *Olc. bidichotomus*, Leym. is very nearly related, which, however, does not seem to have come to us from India, but from the boreal regions, where *Olc. diptychus*, Keys., and *polyptychus*, Keys., from Petschora, form the starting point. The close affinity between the Indian and Russian cephalopodous faunæ is well known, and apparently the group of *Olc. bidichotomus* forms a boreal series parallel with that of the Indo-Mediterranean of *Olc. astierianus*; the appearance of the first group in Europe took place decidedly earlier than that of the latter, and indeed synchronously with that of the Amalthæa and Belemnites of the group *Bel. subquadratus*. The duration of *Olcostephanus* in Europe is very short, they do not seem to extend beyond the Neocomian, whilst they persist in India for a long time in the form of flat types with wide umbilicus.

The character of *Olcostephanus* in contrast with *Perisphinctes*, consists in a shorter body-chamber, embracing only about two-thirds of a whorl, with a simpler aperture, bordered with a smooth margin; the presence of ears has been observed only in *Olc. Cautleyi*, which stands on the limits of both the above genera. Constrictions directed forward in the group *Olc. astierianus*, very strong, wanting as a rule, in that of *Olc. bidichotomus.* Lobular line, as a rule, consisting of a siphonal, two lateral, and three auxiliary lobes, the last of which sometimes are somewhat dependent. External side without keel or furrow, only in a very few are the ribs there interrupted.

Thirty-three species.

Olcostephanus Bhawani, Stol. T. 111, figs. 658, 659.

Genus SCAPHITES, Parkinson.

The *Scaphites*, with the exclusion of *Sc. Yvanii*, form a very good natural group, very distinctly characterized by the involute spiral of the chambered portion of the tube, to which but one very short evolute hook is attached, by their aptychus, which by its form, its want of strong longitudinal sculpture, and the surface covered with granules, is allied to the aptychi of *Perisphinctes*, and by the appearance of auxiliary lobes which are wanting in all other evolute forms. The form of the aptychus decidedly indicates that they are serially to be connected with the *Perisphinctes*-stem, and the form of the inner whorls of the geologically old species, which agree entirely in form with *Olc. Guastaldinus*, indicate strongly their connection with *Olcostephanus*, which is also confirmed by the form of the aperture.

Thirty-four species.

Scaphites æqualis, Sowb. T. 100, fig. 527.

Genus **HOPLITES**, Neum.

Derived from the group of forms represented by *Perisphinctes involutus*, with moderately narrow umbilicus and high whorls; thickness very variable. Margin of aperture and length of body-chamber unknown. Sculpture consisting of divided and curved ribs, which originate near the umbilicus or in the middle of the flanks in small, thickened, primary ribs or a tubercle; ribs interrupted on the external side, often separated by a deep furrow, or at least feebler at this point; ribs enlarged at both extremities, weaker at the middle of the flanks. Lobular line complicated, with branches and numerous auxiliaries; lobular bodies not very plump; saddles as wide or (mostly) wider than the lobes. First lateral always longer than the siphonal lobe; second lateral strikingly short; auxiliary horizontal or very slightly dependent.

Besides the typical representatives of the genus we will here place a small laterally divergent group, which is peculiarly characterized by a very narrow umbilicus, very broad, flat ribs, separated by very narrow furrows; it is this, the group embracing *Hopl. Dumasianus*, Orb., *provincialis*, Orb., *compressisimus*, Orb., *galeatus*, Buch, *Favrei*, Oost., *didayanus*, Orb., which, in spite of their different appearance, may be included in *Hoplites*, since the inner whorls indicate a very close relationship with *Hopl. Boissieri*.

As an aberrant form, *Hopl. regularis*, remains to be mentioned, which diverges from all other *Hoplites* in the less number of lobes which it possesses, whilst in other respects it is closely allied to the true *Dentata;* in regard to its true relations, further researches are necessary.

Forty-five species.

Hoplites archiacianus, d'Orb. T. 112, figs. 668, 669.

Genus **ACANTHOCERAS**, Neumayr.

From *Hoplites*, near its origin, a large series diverges, which perchance embraces the groups: Angulicostati, Crassecostati, Nodosocostati, Mamillares, and Rotomagenses, and which, after long consideration, I separate as an independent genus. Isolated forms are found, which combine the characters of *Acanthoceras* and *Hoplites* without approaching the point of divergence (origin) of either.

The diagnosis of the genus *Acanthoceras* may be presented in the following manner:

Successors of the group of *Hoplites abscissus*, with a moderately wide umbilicus and not very elevated whorls. Margin of aperture and length of body-chamber unknown. The sculpture consists of quite straight ribs, which become constantly stronger from the suture outwards to the external side, which are frequently ornamented with a greater or less number of tubercles or nodes, and are most curved in young individuals. The development of the external side is very variable, the middle line sometimes with uninterrupted ribs, sometimes with a furrow, sometimes with a line of tubercles, the elements of which attempt to unite into a keel. Lobular line much reduced; besides the two laterals on the flanks there is at most one auxiliary, or a row of two to three extremely small deep-lying auxiliaries; bodies of the lobes and saddles plump and broad, the last broader than the first, no branching, but only a dentation of the lobes. Siphonal and first lateral usually not very different in size, the first often larger than the last; second lateral much smaller than the first, both one-pointed.

Thirty-six species.

Acanthoceras Rotomagense, Brong. T. 103, fig. 563.

Genus **STOLICZKAIA**, Neumayr.

Forms allied to *Hoplites dutempleanus*, with expanded body-chamber, embracing three-fourths? of a whorl. Margins of aperture curved, produced at the middle of the flanks, slightly emarginate at the external side. Inner whorls with radial ribs which are not interrupted on the external side, and usually here attain their maximum strength; body-chamber smooth or with thickened ribs; external side without keel or furrow. Lobular line branched, consisting of a siphonal, two lateral, and one or more less dependent sutural lobes.

Eight species; India.

Stoliczkaia dispar, Stol. T. 112, figs. 664, 665.

Genus **CRIOCERAS**, Leveillé.

A part of the evolute cretaceous Ammonites is connected with *Lytoceras*, another with *Olcostephanus*; for a third group, which we will here embrace under the name of *Crioceras*, the direct connection with *Acanthoceras* and especially with *Ac. angulicostatum*, is shown by the investigations of Pictet and Quenstedt; it is these evolutes rolled up in one plane, in which, beside the siphonal and the one-pointed antisiphonal lobe, there are on either side two asymmetrically divided laterals and auxiliaries present. Here also, according to the different curvature, several genera have been established, upon the small value of which Quenstedt has expressed himself, and in fact the greatest capriciousness reigns in referring species to one or another of them; Pictet had already referred all the forms belonging here, which to his time had been embraced under *Crioceras* or *Ancyloceras*, and *Toxoceras* also, cannot be separated from it; for the whole group of forms, the oldest name, *Crioceras*, must be retained.

Ammonites diverging from *Acanthoceras*, rolled up in one plane, the whorls of which are not or only partially in contact. Besides the siphonal and the one-pointed antisiphonal lobe, there are, on either side, but two lateral lobes, asymmetrically divided into paired halves.

Sixty-two species.

Crioceras cristatum, d'Orb. T. 100, fig. 522.

Genus HETEROCERAS, d'Orb.

Heteroceras embraces a number of forms of very peculiar shape, which stand in the same relation to *Crioceras* as *Turrilites* to *Hamites*. Our genus differs from *Crioceras* in departing from the spiral coiled in one plane, from *Turrilites* in its asymmetrically divided lateral lobes, but besides this in its whole habitus and its quite abnormal curvature, known from the figures of d'Orbigny. Besides the three typical species, *Turrilites Senequieri*, d'Orb., is also to be placed here.

Heteroceras Emericii, d'Orb. T. 101, fig. 532.

Genus ASPIDOCERAS, Zittel.

External form very variable, sometimes flat with wide umbilicus, sometimes inflated with a narrow umbilicus; external side rounded or with a broad external furrow, never with a carina or angle. Sculpture consisting of one or two rows of tubercles or wanting. Ribs, as a rule, present only in the young state. Margin of aperture simple (*Asp. aporum* with ears?), body-chamber short, embracing two-thirds of a whorl. Cellulose aptychi. Lobular line tolerably simple; siphonal, two laterals, also often (in the geologically younger species) an auxiliary lobe. Lobes not much cut (with the exception of *Asp. Altenense* and *circumspinosum*); bodies of the lobes and saddles broad.

The development of *Aspidoceras* is pretty well known; the branching off of *Perisphinctes* seems to take place in the upper Callovian. If one breaks away the outer whorls of one of the simpler, geologically old types, for example *Asp. perarmatum*, one finds within a kind of sculpture, which leaves no doubt in regard to the origin of the groups *Perisphinctes aurigerus* and *curvicosta;* curved ribs and tubercles are identical in both, and the last are developed into the external row of tubercles of *Aspidoceras*, amongst which the forms with but one external row of tubercles represent the original type, from which the bi-tuberculate Perarmata are first developed, which in the young stages, according to the stage of the ribs and tubercles, pass through a second with only an external row of tubercles, then definitely the third with two rows of tubercles.

To the large series of Perarmata with double series of tubercles, which have no auxiliary lobe, several other series are allied;

next one which loses wholly or partially the external row of tubercles, as *Asp. Tietzei* and *acanthomphalum*, and from the first form the species with a broad external furrow take their origin, as *Asp. pressulum*, *Knopi*, *Beckeri*, *hybonotum*, etc. Finally, the inflated forms of Cyclota are to be referred to the Perarmata, which may easily, on account of their great thickness, take up an auxiliary lobe, and also, analogous to the slender forms, gradually lose the outer, later the inner row of tubercles, becoming quite smooth.

Aspidoceras reaches the highest point of its development in the Kimmeridgian, and dies out in the Neocomian.

Forty-eight species. Jurassic, Cretaceous.

Aspidoceras longispinum, Sowb. T. 102, figs. 548, 549.

Genus **PELTOCERAS**, Waagen.

This genus was established by Waagen in a preliminary communication upon the cephalopods of the Jurassic of Cutch in India; it embraces, according to my understanding, forms, which like *Aspidoceras*, branch off from *Perisphinctes* and develop tuberculate ribs; but whilst *Aspidoceras* is to be traced to the *Perisphinctæ* with curved ribs, the stem-form here *Peltoceras annulare* presents quite straight ribs. A difference between both genera lies in the appearance of persistent ears in *Peltoceras;* it is of importance to know the aptychus of the latter. The oldest representatives appear in the upper Callovian, and in the upper Oxfordian the genus already dies out with *Pelt. bimammatum.*

Thirteen species.

Peltoceras Arduennense, d'Orb. T. 112, figs. 666. 667.

Genus **SIMOCERAS**, Zittel.

Shell very flat, discoidal, umbilicus wide, with numerous whorls, which increase in thickness very slowly (except in the geologically oldest forms); external side rounded or grooved; sculpture seldom absent, consisting mostly of straight, simple or forked ribs, which are interrupted during most of the lifetime of the animal; interrupted at any rate in the young state on the external side, and which are often ornamented with tubercles or strongly swollen on the last whorl; isolated constrictions directed forwards on all the whorls. Body-chamber long, at least three-quarters of a whorl, usually attaining a greater length. Aptychus? Lobular line not very complicated, understood in the sense of a reductive change. Siphonal lobe largest, external saddle much developed and broad, laterals one-pointed, very small in the geologically younger forms.

The genus *Simoceras* begins in the upper part of the middle Jurassic, with the group *Sim. sulcatum*, *anceps*, *Greppini*, *Fraasi*, *Rehmanni*, which stand very close to typical *Perisphinctes*, differing from them only in somewhat more developed constrictions, the appearance of tubercles on the ribs and the presence of an external furrow, so that it is in the highest degree probable that both genera spring from a common root, especially as *Perisphinctes* is inclined in a high degree to develop an external furrow. These stand very close to forms from the lower and middle parts of the upper Jurassic, as *Sim. contortum*, Neum., and *Agrigentinum*, Gem. Gradually a change of such a kind steps in, as to replace the originally present divided ribs with more and more simple ones until the first are entirely replaced, whilst at the same time the ribs on the body-chamber separate more and more, and become strongly swollen. Out of these the extremely developed, strange species of the Tithon are evolved, for which the genus was originally established, with in part very prominent, in part rudimentary sculpture, decidedly reduced lobular markings, and with the external lobe of the aperture bent upwards.

The highest development is attained by *Simoceras* in the Tithon, where a great diversity of forms are developed; but the genus already begins to die out in the upper Tithon. The geologically oldest forms are distributed in the Mediterranean as well as in middle European Jurassic, more prominently in the latter. The younger types are almost entirely confined to the Mediterranean province, and appear northwards in quite isolated, extremely rare species (*Sim. Randenense* and *Doublieri*).

Twenty-six species.

SIMOCERAS JOORAENSIS, Waagen. T. 112, figs. 670, 671.

OPERCULA OF AMMONITES.

There are constantly found associated with, and generally within the aperture of Ammonites, horny or shelly plates, which are generally supposed to be opercula; if so, they were probably secreted by the disk or hood, which, formed by the coalescence of the two dorsal arms, closes the aperture of the recent Nautilus, and corresponds to the velamentous arms of the Argonaut; but if the Ammonites were dibranchiates allied to Spirula—that is having internal shells, they could not have possessed opercula.

Prof. Waagen has adopted the theory first suggested by Keferstein and advocated by Zittel that the aptychi were connected with the nidamental gland; and he has grouped the family according to the presence, absence or peculiarities of these bodies, as follows:

A. Nidamental gland without solid integument or Aptychus: *Phylloceras*, *Lyttoceras*, *Arcestes*, *Pinnoceras*, *Trachyceras*.

B. Nidamental gland with an Aptychus.

1. Gland simple, not divided.
   - Aptychus horny: *Arietes*, *Ægoceras*, *Amaltheus*.
   - Aptychus calcareous: *A. numida*, Coq. (shell unknown).
2. Gland double, aptychus calcareous.
   - Aptychus furrowed externally: *Harpoceras*, *Œkotraustes*, *Oppelia*, *Haploceras*, *Scaphites?*
   - Aptychus thin, granulated externally: *Stephanoceras*, *Perisphinctes*, *Peltoceras*, *Cosmoceras*.
   - Aptychus thick, smooth and punctate externally: *Simoceras*, *Aspidoceras*.

In the absence of positive knowledge as to the true relations of the Aptychi with the shells of Ammonites, and until much more extensive observations shall have been made, the groupings indicated above must be regarded as simply provisional.

The latest authority on the subject (Prof. Owen, *Zool. Proc.*, 955, 1878) regards the aptychi as true opercula.

The following "genera" of Aptychi have been characterized:

Trigonellites, Parkinson. Shelly, divided into two plates by a straight median suture; external surface smooth or sculptured, inner surface marked by growth lines.

Associated with the round-backed Ammonites, and a single specimen with Goniatites. Nearly fifty varieties have been described.

Meyer considered them bivalve shells, and described them under the name of *Aptychus;* Deslongchamps with the same impression, called them *Munsteria;* d'Orbigny thought them plates of cirripedes, and Deshays believed them to be the gizzards of Ammonites; Coquand compared them with *Teudopsis*, and they certainly resemble in some degree that genus, as well as *Beloteuthis*, *Belemnosepia*, etc.

A. LAMELLOSUS, Park. Pl. 104, fig. 573. Oxford Clay, *Solenhofen.*

T. LATUS, Brown. Pl. 104, fig. 575 *a.*

TRIGONELLITES associated with an Ammonite. Pl. 104, fig. 574.

Genus ANAPTYCHUS, Oppel. Horny and flexible, in a single piece.

Associated with the *Arietes* group of Ammonites.

Anaptychus of AMMONITES COSTATUS. Pl. 104, figs. 575, 576.

BEAKS OF TETRABRANCHIATES.

These are found associated with fossil Nautili and occasionally Belemnites, but never with Ammonites. The upper beaks have been described under the name of RHYNCHOLITES, the lower ones as CONCHORHYNCHUS.

R. ASTIERIANA, d'Orb. Pl. 104, fig. 577.

C. AVIROSTRIS, Bronn. Pl. 104, fig. 978.

C. OWENII, Bronn. Pl. 104, fig. 579.

PELTARION, Deslongchamps. This was formerly believed to be the mandibular armature of tetrabranchiates, consisting of circular or transversely-oval calcareous plates, with rounded anterior and produced and truncated posterior margins. Through the researches of M. Crosse (*Jour. de Conch.*, 3 ser., xv 57, 1875), there is no doubt that these Peltariæ are opercula of fossil species of *Neritopsis;* they resemble the operculum of the recent *N. radula.*

Several species have been described from U. Lias to Coralline Rag.

P. BILOBATUM, Desl. Pl. 104, figs. 580, 581. Upper Lias of *Normandy*.

Genus **POLORTHUS**, Gabb.

The aggregated mass of specimens forming the type of this genus was originally referred to Teredo; subsequently, in describing the genus, Mr. Gabb referred it to Vermetidæ, and in 1872 he finally believed it to be a cephalopod connecting the Orthoceratidæ with Beatriceæ. The aggregate character, the long, narrow, irregular tube, the non-molluscan character of the partitions forbid this determination: I am convinced that *Polorthus* is not a mollusk, and *Beatricea* itself is now referred doubtfully to the Spongiadæ.

INDEX

TO GENERA AND SPECIES, INCLUDING SYNONYMY.

* Corrections of scientific names are scarcely allowable; it is preferable to retain original names with all their faults, and thus have a settled nomenclature rather than allow changes, which (made with good reason in this instance) may not always meet with unchallenged acceptance.

REFERENCE TO PLATES.

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1. The brain, corresponding to the central commissure of the Nautilus. 2. The anterior sub-œsophageal mass, or *Pes anserinus*, giving off (5) the nerves to the arms. 3. The great reniform or ophthalmic ganglions. 4. The posterior sub-œsophageal mass, giving off (6) the nerves to the cloak; and (8) the nerves to the viscera. 7. The ganglion stellatum. 9. Two small spherical bodies attached to the pedicles of the ophthalmic ganglions.

Plate 3.

1. Anatomy of Nautilus Pompilius. From Owen, Memoir on Pearly Nautilus, pl. 2.. 25

a. The mantle. *b.* Its dorsal fold collapsed. *c.* Its anterior margin. *d.* The process of the mantle which separates the funnel from the head. *e.* Convexities produced by the ovarian gland. *f.* Orifice of the funnel a little widened; the funnel itself is drawn down to show the surface of the oval sheath on which it rests. *g.* The levatores infundibuli exposed by laying open the canals in which they were concealed. *h.* The hood. *i.* Its superior plane surface longitudinally divided. *k.* The cut surfaces. *l.* The smooth internal surface of the oval Sheath. *m.* The digitations, showing their orifices, the tentacles being retracted (the entire number is given on the right side). *m′.* The large papillose digitation. *n.* The inferior parietes of the oral sheath. *o.* The external labial processes. *p.* The internal labial processes. *q.* The convex outer surface of the organ of smell. *r.* The labial tentacles. *s.* One of the ophthalmic tentacles. *t.* The eye. *u.* The inferior ridge.

2. An ophthalmic tentacle magnified, showing its laminated structure.
3. A digitation with its tentacle magnified.

a. The free extremity of the digitation. *a′.* The cut-surface separated from the parietes of the head. *b.* The digital tentacle. *b′.* The cut-surface of the tentacle, exposing *c.* The central nerve.

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rows of teeth and an unarmed row of plates on either side; those of the median row have three fangs, of the next on either side two fangs, whilst the two outer rows on both sides are simple, acute and strongly curved.

7. Sepia officinalis. Troschel, ibid., f. 7.
8. Sepia Orbignyana. Targioni, l. c., t. 7, f. 2.

Plate 7.

1. Circulation of Eledone moschata. Keferstein, t. 117. f. 2....... 35
   J. Siphon. *A.* Elevator of the siphon. *v b.* Veins of the arm, *v c.* Vena cava. *o e.* Gullet. *g s t.* Stellar ganglion. *a.* Anus. *z.* So-called spleen. *b r.* Branchiæ. *a b r.* Branchial artery. *c b r.* Branchial heart. *m b r.* Branchial muscle. *v b r.* Branchial vein. *r.* Urinal bladder. *t p.* Tubulus peritonealis. *c.* Heart. *s.* Salivary glands.
2. Circulation of Octopus vulgaris. Milne-Edwards, Ann. Sci. Nat., 3 ser., Zool., iii, t. 14.................................... 35
   v b. Arm veins. *J.* Siphon. *a.* Anus. *v c.* Vena cava. *i.* Intestine. *a b r.* Branchial artery. *c b r.* Branchial heart. *v b r.* Branchial vein. *z.* Branchia. *c.* Heart. *o v.* Ovary. *s v.* Sinus venosus. *a o.* Aorta. *h.* Liver. *o c.* Eye.
3. Circulation of Octopus vulgaris. Milne-Edwards, l. c., t. 16.... 35
   h. Liver. *s v.* Sinus venosus. *o e.* Alimentary canal. *v.* Stomach. *v g e n.* Genital vein. *c b r.* Branchial heart. *s v.* Sinus venosus. *c v.* Canalis venosus. *o v.* Ovary. *c.* Heart. *i.* Intestine. *v c.* Vena cava.

Plate 8.

Nautilus Pompilius in its shell. Owen, Memoir on the Pearly Nautilus, pl. 1...5, 38
a. The mantle. *b.* Its dorsal fold, applied to the involute convexity of the shell. *c.* Its free anterior marg,n. *d.* The orifice for the passage of the funnel. *e.* The convexity produced by the ovarian gland. *f.* The horny girdle for the adhesion of the mantle to the shell. *g.* The horny laminæ covering the extremity of the left shell-muscle. *h.* A portion of the shell, which was left adhering to this muscle, *i.* The siphon. *k.* The funnel. *l.* Left lateral process of funnel. *m.* Left crus or pillar of funnel. *n.* The hood. *o.* Exterior digitations of the left side. *o′.* The larger one, with a papillose surface like that of the hood. *p.* Digital tentacles, protruded from their sheaths. *q.* The groove which separates the hood from the papillose digitation. *r.* Ophthalmic tentacles. *s.* The eye. *t.* Its peduncle. *u.* Inferior ridge or rudimentary eyelid. *v.* The ridge running from this to *w.* The pupil. *x.* Partitions of the chambers. *y.* The septal tubes which gives passage to the membranous siphon. *z.* The chamber of occupation.

Plate 9.

1. Circulation of Sepia officinalis. Hunter, Cat. Mus. R. Coll. Surgeons, ii, t. 21... 35
   b r. Branchiæ. *a b r.* Branchial artery. *v b r.* Branchial vein. *v v.* Origin of the stomachic veins. *c.* Heart. *c′.* Auricle. *a o.* Aorta. *c b r.* Branchial heart. *v c.* Vena cava. *r.* Renal organs.

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where it is imbedded in *r*, the muscular stem of the gill laid open. *p*. The larger branchia of the right side, showing the venous surface. *p'*. The same of the left side, showing the venous surface. *q*. The smaller branchiæ of the right side, showing the arterial surface, with *r*, the fleshy skin entire, the dotted line indicating the passage of the branchial artery into it. *q'*. The smaller branchia of the left side. *s*. The common stem of the branchiæ, by which they adhere to the inner surface of the mantle. 10. The branchial veins. 11. The valves placed at their terminations in the ventricle. *t*. The ventricle or systemic heart. laid open. 12. The origin of the lesser aorta. 13. The artery of the glandular ovarian apparatus. 14. The siphonic artery. 15. The artery of the intestine. 16. The larger aorta. 16'. Its muscular origin or the continuation of the ventricle. 17. The valve at the extremity of this part.

2. A lamina of the larger branchia magnified, showing its subdivisions into the smaller laminæ............................ 35
   The letter and figures as in fig. 1. Owen, l. c.

Plate 14.

1. Female organs of Sepia officinalis. Milne-Edwards, in Cuvier's Régne. Anim. Moll., t. 1, e................................ 38
   a. Anus. *i*. Intestine. *o v*. Ovary. *o d'*. Oviducal aperture. *o d*. Oviducal gland. *g n*. Nidimental gland. *g n*. Accessory glands.
2. Female organs of Eledone moschata. Keferstein, l c., t 121, f. 6. 38
   o d'. Oviducal apertures. *x*. Oviducal glands. *o v*. Ovary.
3. Male organs of Loligo vulgaris. Duvernoy, Mém. Acad. Paris, xxiii, t. 7.. 38
   t. Testicle. *t'*. Testicle case. *v d*. Vas deferens. *v d'*. Its opening. *v s*. Vesicula seminalis. *p r*. Prostrate gland. *b s p*. Spermatophore reservoir. *p*. Penis.
4. Male organs of Octopus vulgaris. Cuvier, Mém. sur les Moll. Céph., t. 4.. 38
   References as in fig. 3. *m*. Muscle.
5. Male organs of Sepia officinalis. Duvernoy, l. c.................. 38
   t. Testis. *v d*. Vas deferens *v s* Vesicula seminalis. *p r*. Prostrate. *b s p*. Spermatophore reservoir. *p*. Penis and genital aperture.

Plate 15.

Hectocotylized Arms.

From Verany, Céphalopodes de la Méditerranée, t. 41.............. 39

1. Tremoctopus Carenæ. The arm developed.
2. Ibid. The arm not developed from its sack.
3. Ibid. The terminal vesicle opened and the sinuous white thread exposed.

4, 5. Side and front view of the Hectocotyle of the Octopus.

6. Hectocotyle of the Argonaut. Tricocephalus acetabularis of Chiaje, as figured by that author. *a*. Orifice of the mouth. *b*. Alimentary canal. *c*. Ovary. *d*. Spotted membrane. *e f*. Double series of suckers.
7. Hectocotyle of the Argonaut, as figured by Costa. Actual size.

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8. Hectocotyle of the Argonaut, enlarged nearly 20 times. *a b.* Trunk. *c.* Terminal appendage. *e f.* The two tentacular cirri. *l.* Suckers. *i.* Cavity, divided into three or four compartments. *x* g. Chromatophores.
10. Hectocotyle of the Argonaut enlarged. *a.* Ventral bace with the suckers and the medial portion containing the muscular integuments. *b.* Dorsal face. *c.* Anterior and *d.* Posterior side of the body. *e.* Appendages of the posterior side in natural position. *f.* Membranous appendage. *g.* Dorsal crest. *h.* Opening at the extremity of the crest. *i.* Spermatic capsule with the chromatophores.
11. The same, with the appendage detached from the spermatic capsule. References as in preceding figures. *k.* A part of the penis. *l.* Median part of the body containing the muscular canal.
13. Hectocotyle of Tremoctopus enlarged. *a.* Anterior cupules. *b.* Posterior cupules. *d.* Posterior part of body. *e.* Spermatic canal. *f.* Spermatic mass. *g.* Penis. *h.* Sheath.
14. The same dorsal side. The references are the same. *h.* Chromatophores.

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Hectocotylized Arms.

From Claus. Archiv für Naturg., i, t. 10, 1858...................... 39

1. Enoploteuthis, Owenii, Ver.
2. Enoploteuthis Margaritifera, Rüpp.
3. Hectocolylized arm of Sepiola Rondeletii.
4. First and second arms of a female Rossia dispar.
5. Third left side arm of male Rossia dispar.

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1, 2. Male of Argonauta Argo. Müller, Zeit. Wiss. Zool., iv, t. 1.. 38
In 2 the arm is enveloped in the sack, in 1 it is developed. Figures four times natural size.

3. Buccal membrane of female Sepioteuthis sepioidea, Bl., showing attachment of spermatophores. Steenstrup, Mem. Acad., Copenhagen, v. ser. x.................................... 38
4. Buccal membrane of female Sepia aculeata, Hass. Steenstrup, l. c. 38
5. Spermatophore of Sepia officinalis. Keferstein, l. c., t. 122, f. 14, Actual length, 8 mil.. 38
6. Anterior end of same, more enlarged. Keferstein, l. c., f. 16.... 38
7. The same, with the sperms pushed forward.................... 38
8. Sperms of same. Keferstein, l. c., t. 121, f. 10................. 38
9. Hectocolylized arm of Scæurgus titanotus. Troschel, Archiv für Naturg., i, t. 4, 1857.. 39

Plate 18.

Structure of Hectocotyles.

Verany and Vogt. Ann. Sc. Nat., 3d ser., xvii, t. 9................. 38

27. A spermatophore of Tremoctopus Carenæ, extracted from its case.
28. Anterior extremity of the same. *a.* Transparent envelope. *b.* Ejaculatory cordon. *c.* Seminal cordon.

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29. Posterior extremity of the ejaculatory (*c*), in continuation with the seminal (*a*) band. *b*. Membrane of the spermatophore. *d*. Commencement of the spiral membrane.
30. A middle portion of the ejaculatory band. *a*. The envelope, in two layers. *b*. The spiral membrane.
31. Anterior extremity of the spermatophore.
32. Extremity of the cup-portion of the hectocotylized arm, with the commencement of the lash and opening of the sack. *a*. Lash. *b*. Muscular band of the lash, continuing in the arm. *c*. Ganglion. *d*. Suckers. *e*, *f*. External and internal layers of the sack.
33. The vesicle opened to show the abnormal arm enrolled within it. Enlarged twice.
34. Anterior extremity of the lash.
35. A portion of the middle part of the lash, considerably enlarged. *a*. Central duct. *b*. Walls of the muscular tube. *c*. Skin which envelopes the lash. *d*. Lateral cutaneous muscles. *e*. Cutaneous ducts.

Plate 19.

1. Argonauta Argo eggs. Fer. and Orb., Céph. Arg., t. 1 ter., f. 2. 44
2. Group of egg cases of Loligo punctata, Les. Amn. Marine Conchology, t. 3, f. 11 45
3. Egg cases of Octopus punctatus, Gabb. From specimens....... 45
4, 5. Egg cases of Sepia officinalis. Fer. and Orb., Seiches, t. 3, f. 3, 3 *a* 45

Plate 20.

1, 2. Mass of eggs and embryo of unknown cephalopod. Zeit. Wiss. Zool., xxiv, t. 39, 40 46
3, 4, 5. Ribbon-like nidus rolled into a cylinder, and embryo of unknown cephalopod. Ann. Sci. Nat., xx, t. 14.......... 46
6, 7. Nidus and embryo of Octopus membranaceus. Fer. and d'Orb., Octopus, t. 28 46
8. Embryo of unknown cephalopod. Jour. Linn. Soc., xi, t. 1..... 46

Plate 21.

Development of cephalopoda (Sepia officinalis). Keferstein, l. c., t. 123 46

Explanation of reference letters and figures:
D. Outer yolk sack. *o*. Mouth. *m b*. Buccal mass. *v*. Stomach. *b r*. Branchiæ. *b i*. Ink-bag. *c h*. Shell. *J*. Siphon. *m c*. Musculus collaris. *c h*. Button cartilage. *n c h*. Neck plate. *C′ C″*. Under and upper head flaps *o c*. Eyes. 1, 2, 3, 4, 5. Arms.

1. Three stages of the "foldings" of Kölliger, prior to oviposition.
2. An egg, somewhat magnified.
3-5. Eggs showing stages of segmentation.
6, 7. Eggs with the capsules cut open, showing the embryos.
8-13. Progressive stages of segmentation.
14-15. Front and side view of Kölliger's fourth stage of development.
16. Embryo in sixth stage.
17-19. Embryo in seventh stage.

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20. Embryo in eighth stage, from the back.
21. Section of an advanced embryo. 1 represents the cephalic and 3 the abdominal portion of the inner yolk-sack.

Plate 22.

Development of Cephalopoda.................. 46

o. Mouth. *D*. Outer yolk-sack. *T*. Tentacles. *J*. Siphon. *o c*. Eyes. *c h*. Button-like cartilage. *b r*. Branchiæ. *i*. Visceral sack. *b i*. Ink-bag. *o t*. Otolithes. *s*. Salivary glands. *v*. Stomach. *v'*. Blindsack. *c*. Heart. *c b r*. Branchial hearts. 1 *to* 5. Arms. 1, 2, 3. Portions of the inner yolk-sack, head, neck and stomach.

1. Embryo of Sepia officinalis, three or four times smaller than its yolk-sack. Kölliker, Entwicklungsgeschichte der Cephalopoden, t. 4, f. 38.
2. Side view of the same. L. c., t. 3, f. 28.
3. Dorsal view of a more developed embryo.
4. A young Sepia officinalis, ventral view, the mantle cut open. Cuvier, Nouv. Ann. du Mus., i.

5 10. Yolk-sack in progressive stages of development. Kölliker, l. c.
11. Portion of egg-cluster of Loligo vulgaris. Fer. et Orb. Céph.
12. Embryo of the same. Fer. et Orb. Céph.
13. A group of eggs of Argonauta argo, Fer. et Orb., l. c., t. 1 ter., f. 6.
14. Egg of Argonauta argo. Kölliker, l. c.
15, 16. Ibid. Appearance of the mantle, head, arms, eyes. Kölliker.
17. More advanced embryo of the same. Kölliker.
18, 19. Matured embryos, dorsal and ventral views. Kölliker.

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1, 2. Octopus aranea. Fer. et Orb. Céphalopodes, t. 5, f. 1, 2...... 111
3, 4. O. octopodia, Linn. O. vulgaris, Lam. D'Orb. in Sagra's Cuba, t. 1, f. 1, 2.. 113

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5. O. octopodia, Linn. O. vulgaris Lam. Fer. et d'Orb., t. 11... 113
6. " sucker. D'Orbigny, Moll. Viv. et Foss., t. 1...... 113
7. " O. vulgaris, Lam. Jeffreys' Brit. Conch., vol. v... 113

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8. O. Salutii, Verany. Céphal. Medit., t. 9...................... 114
9. O. rugosus, Bosc. O. granulatus, Lam. Fer. and d'Orb., t. 6, f. 1... 116
10. O. brevipes, d'Orb. Céphal., t. 17, f. 1........................ 119
11. O. horridus, " " t. 7, f. 3........................ 119

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12. O. aculeatus, d'Orb. Céphal., t. 7, f. 1....................... 120
13, 14. O. aculeatus, beaks, d'Orb. Céphal., t. 23, f. 3, 4.......... 120
15, 16. O. lunulatus, Quoy and Gaimard. Voy. Astrol., t. 6, f. 1, 2. 121

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18. O. superciliosus, Quoy and Gaim. Voy. Astrol., t. 6, f. 4...... 121

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557. " bisulcatus, Brug. Woodward, t. 3, f. 7...224, 227
558, 559. " serpentinus, Schloth. Chenu, Man. i f. 346, 247 .... 224, 234, 254
560. " cristatus, Deluc. Chenu, Man. i, f. 348...224, 244
561, 562. " cordatus, Sowb. Chenu, Man. i, f. 355, 356 . 225
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564. " Metternichii, Hauer. Halst., t. 3, f. 1.....225, 242
565-567. Ammonites. *D.* Dorsal lobe. *L.* Superior lateral lobes. *L'.* Inferior lateral lobes. *V.* Ventral lobe. *V'.* Its arms. *S.* Saddle. *a.* Auxiliary lobes. *d.* Dorsal saddle. *l.* Lateral saddles. *v.* Ventral saddle. Chenu, Manual i, f. 336-340........ 224

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589. Ptiloteuthis foliatus. Gabb. Pal. Calif., ii, t. 19, f. 4........ 155
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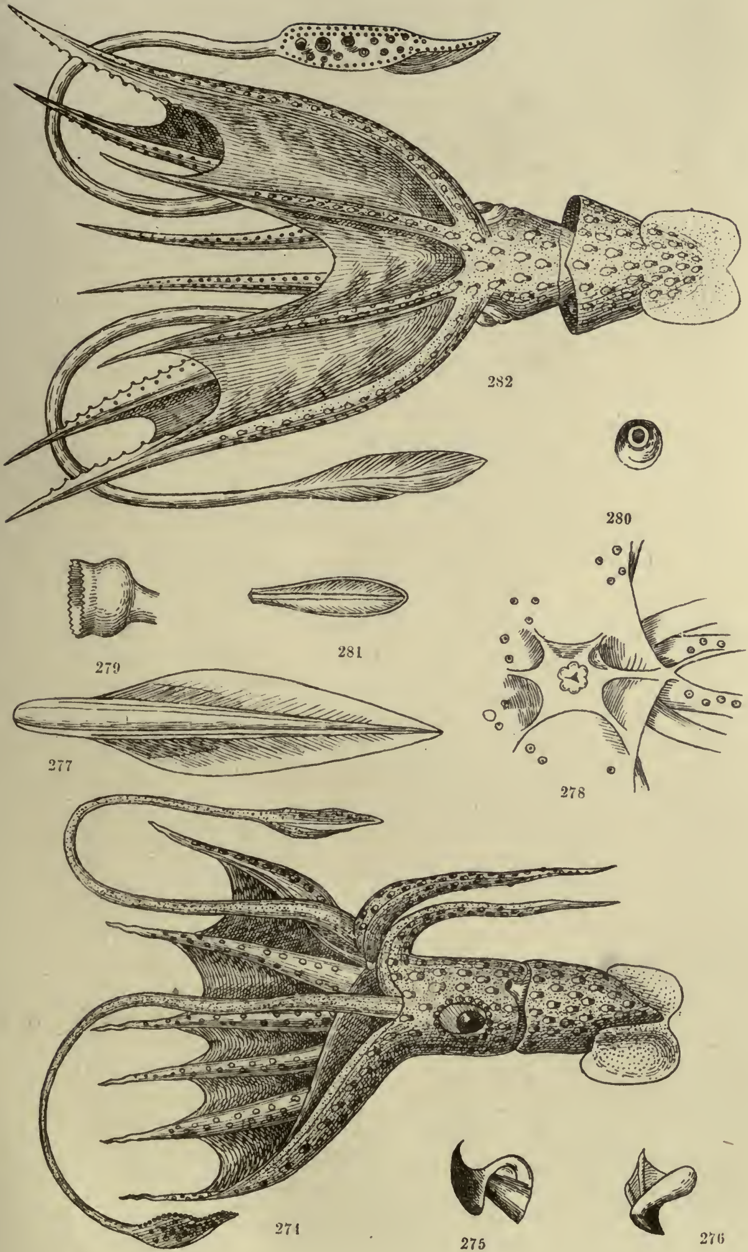
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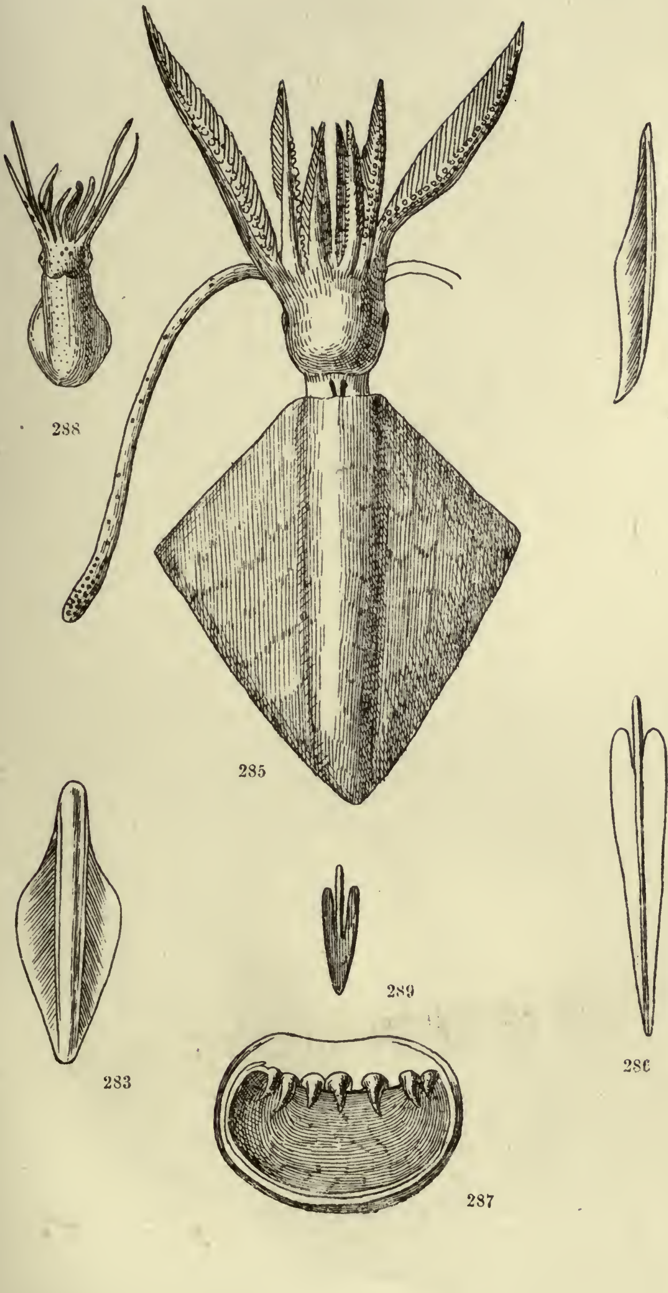

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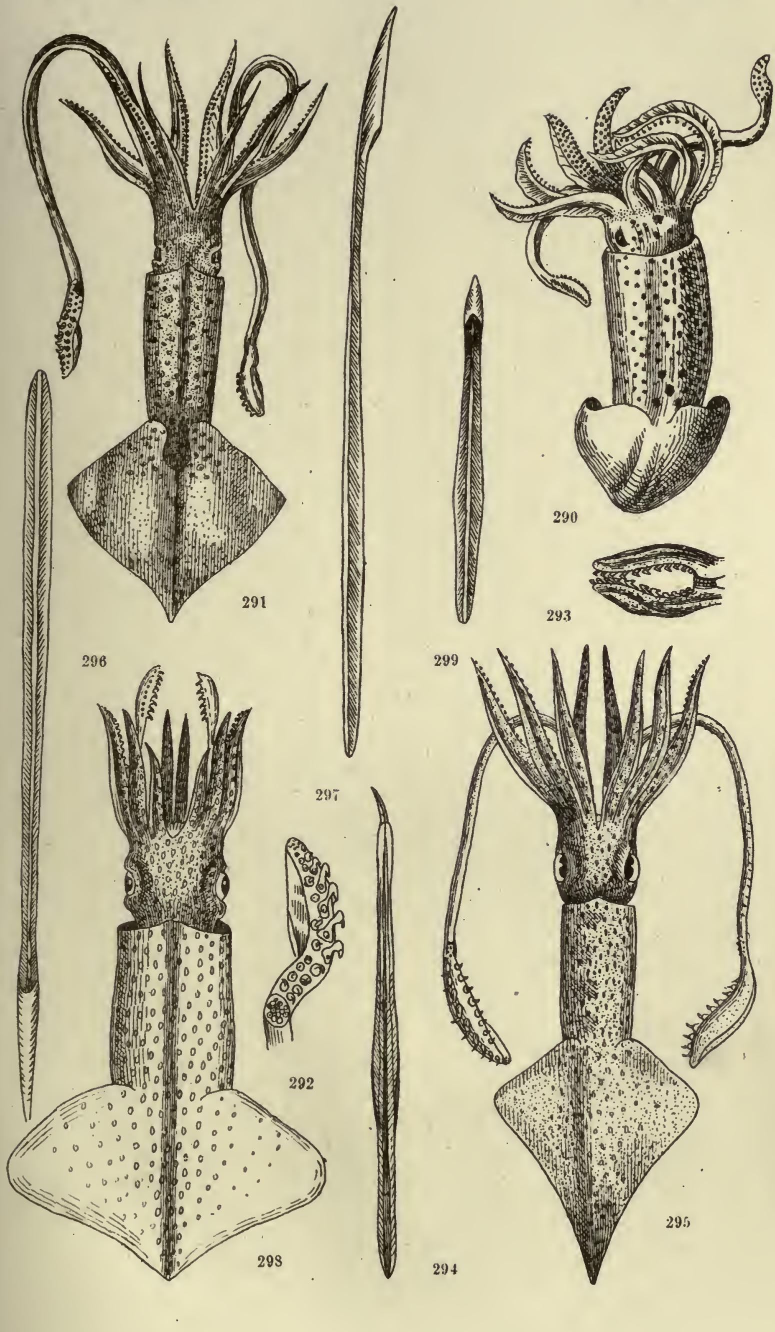
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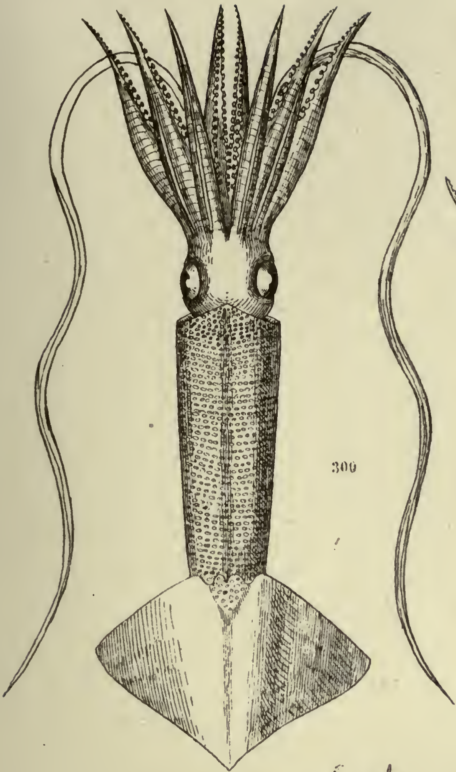

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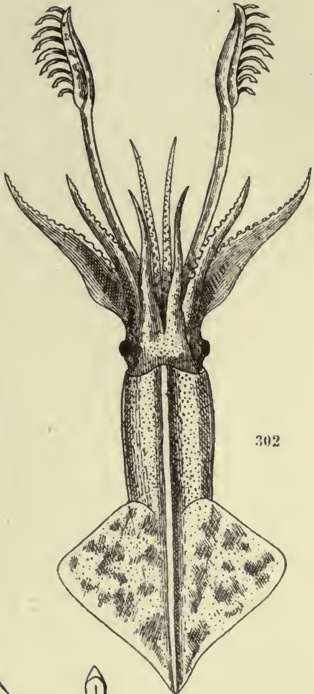

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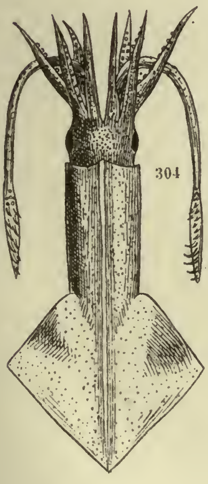

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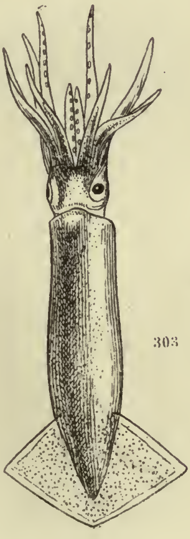

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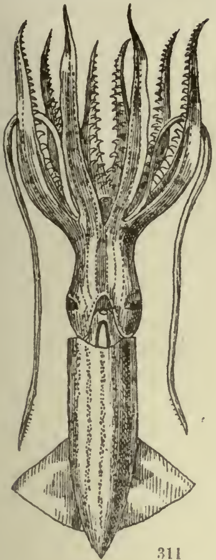
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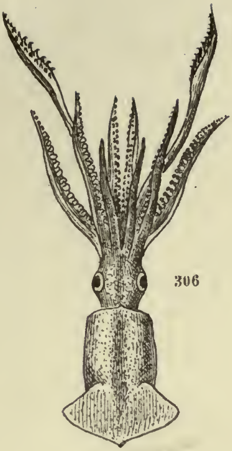
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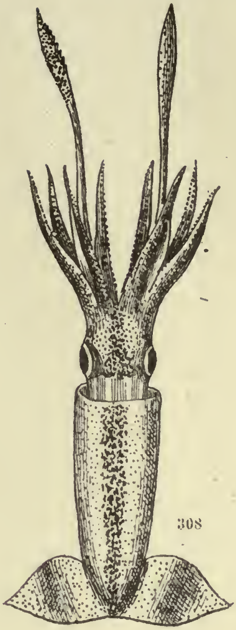
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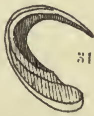
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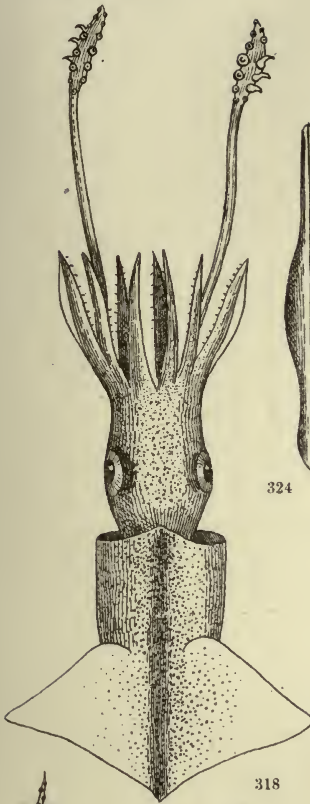

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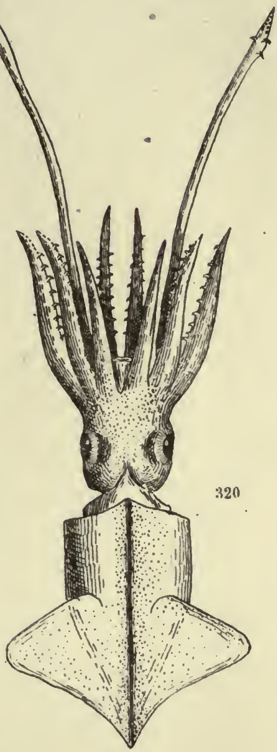

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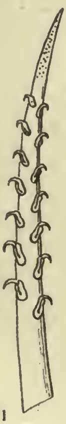

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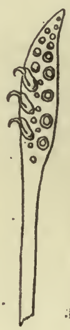

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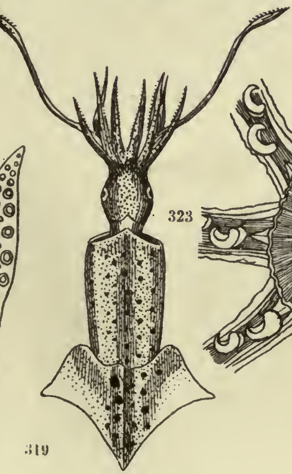

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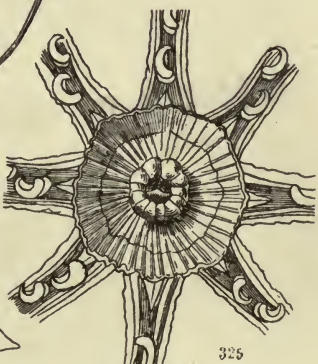

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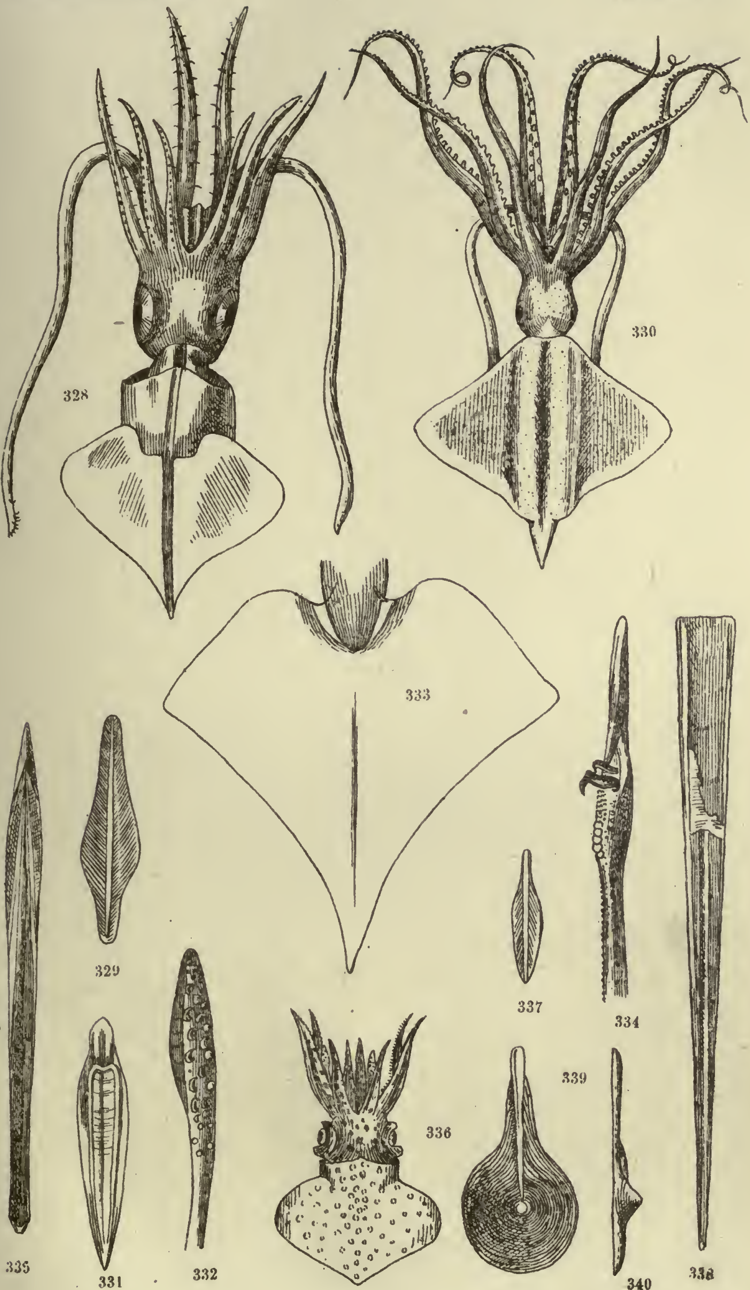
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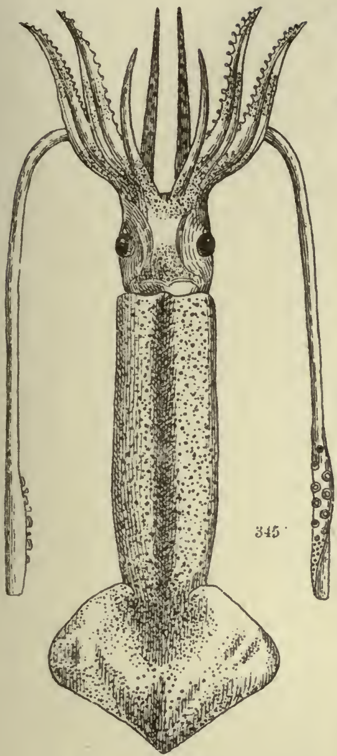

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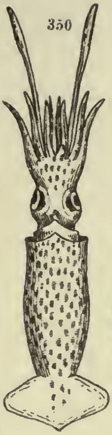

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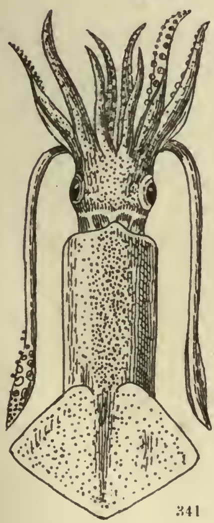

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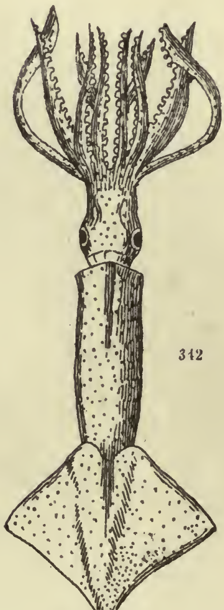

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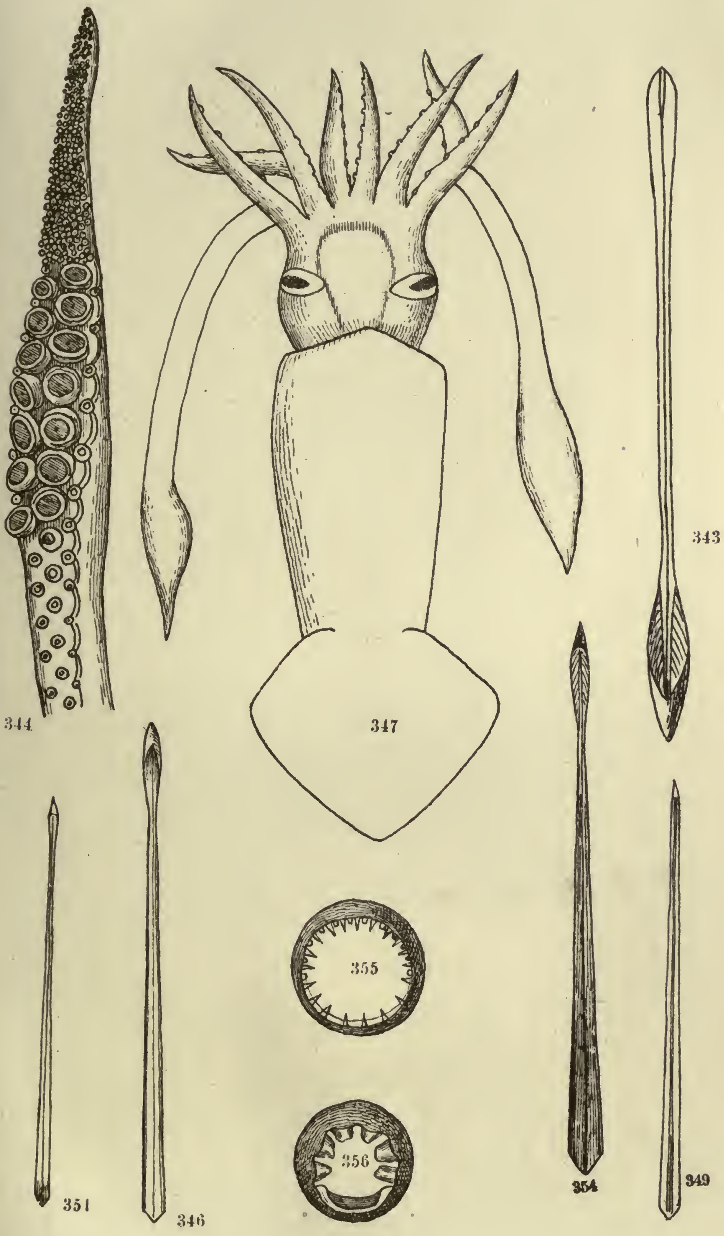

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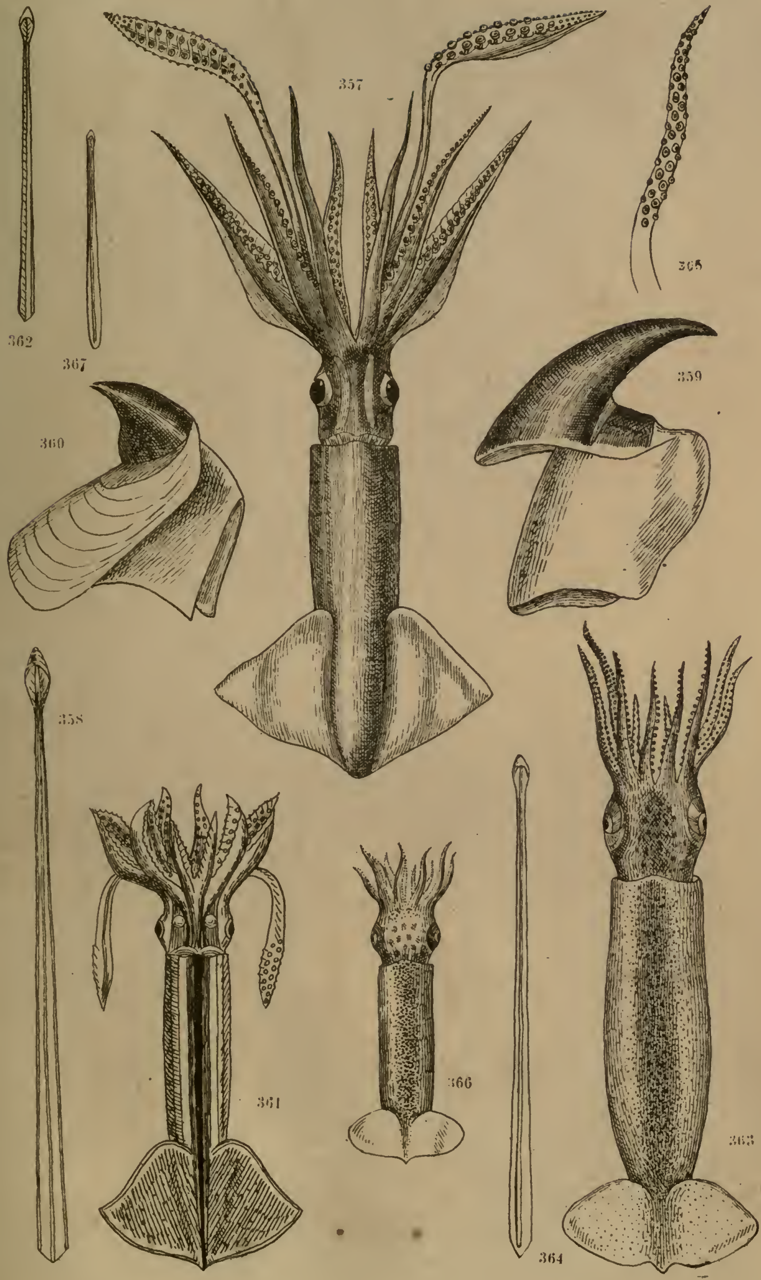
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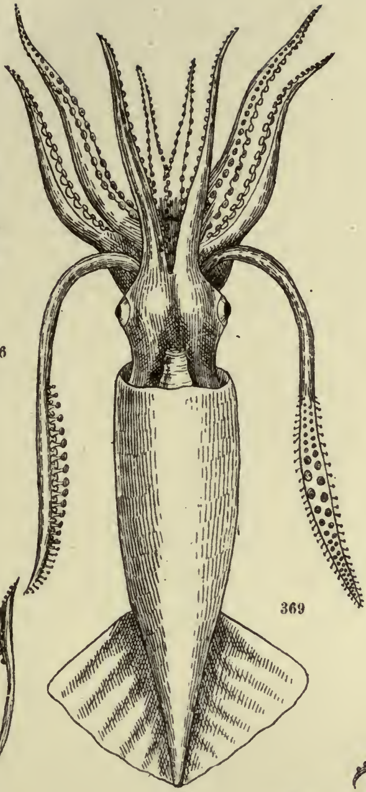

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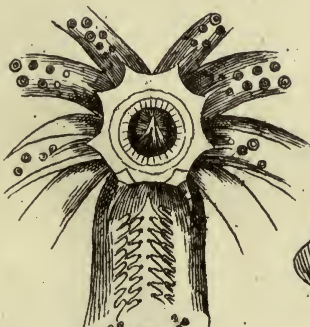

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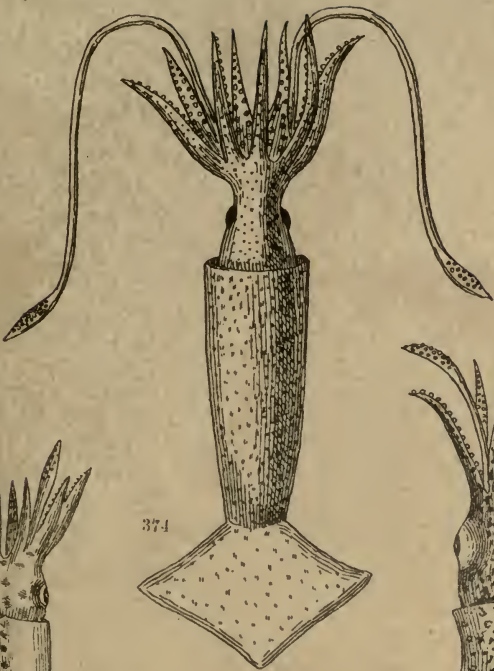

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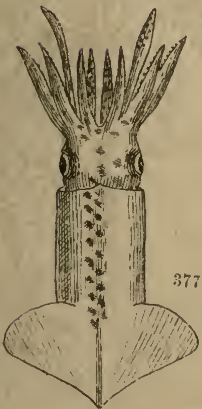

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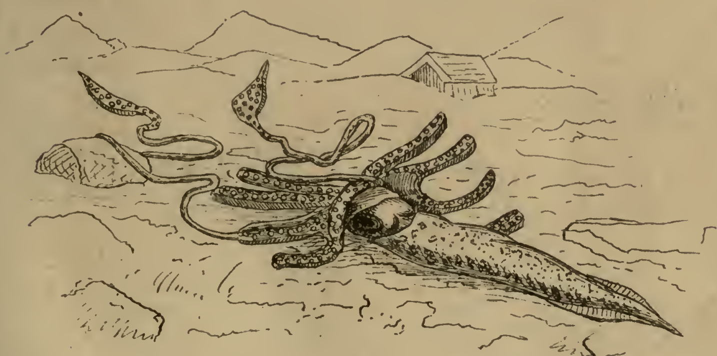

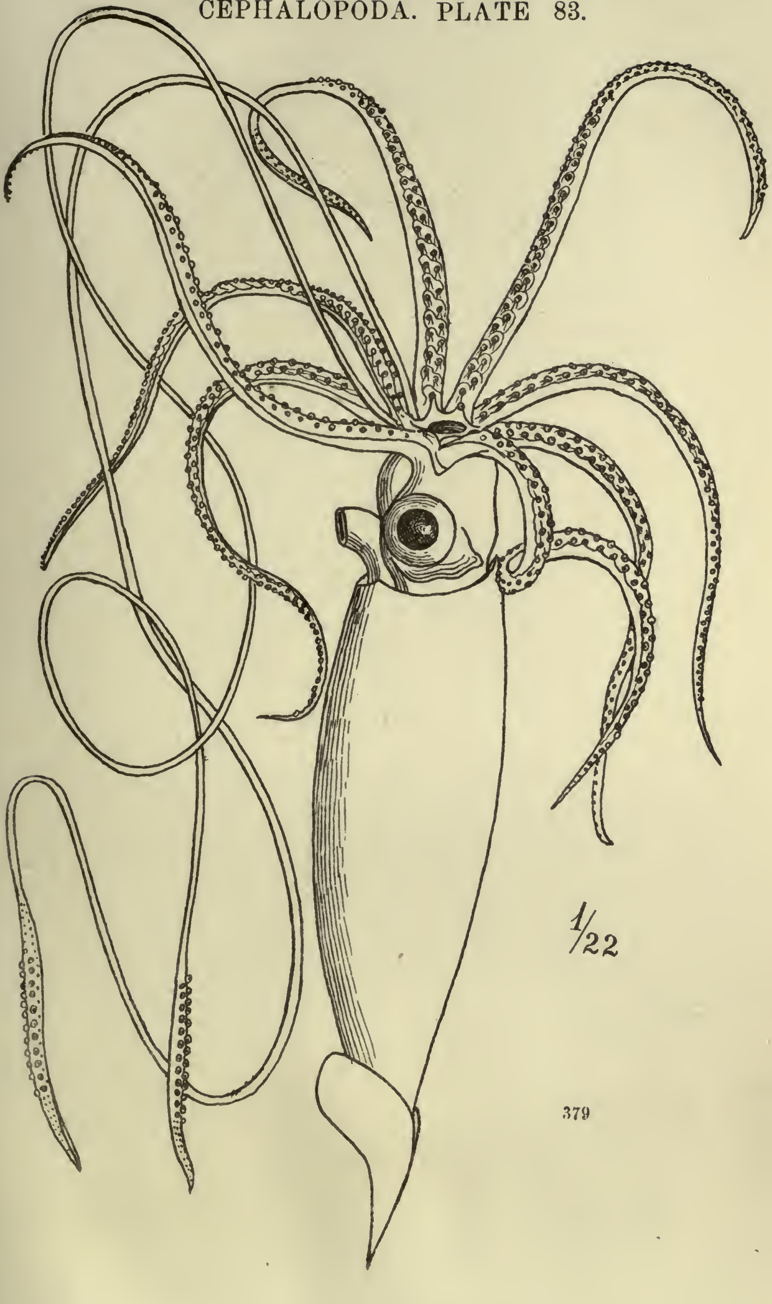

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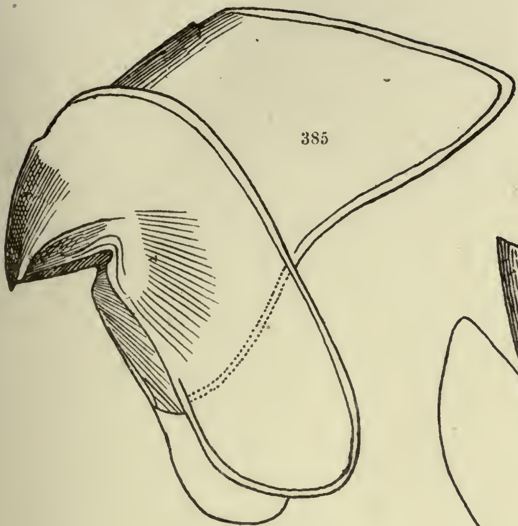
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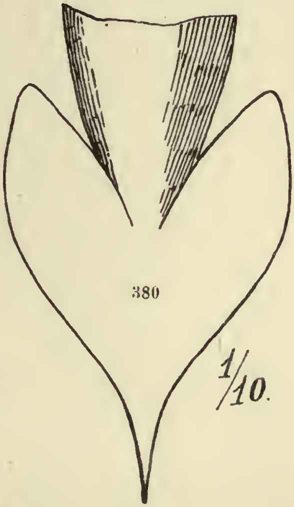
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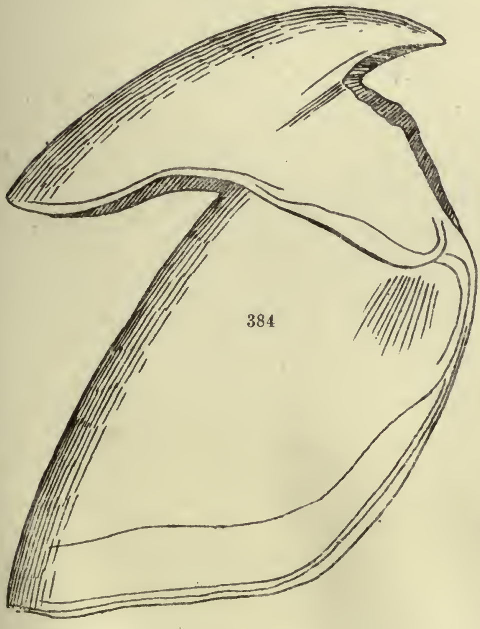
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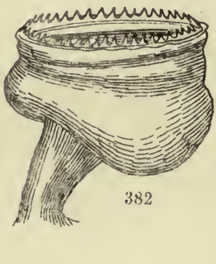
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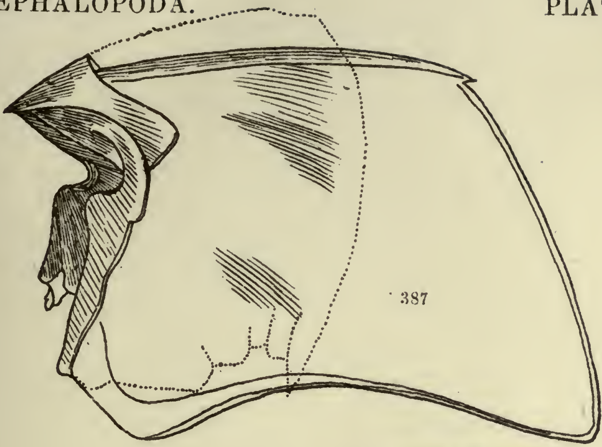

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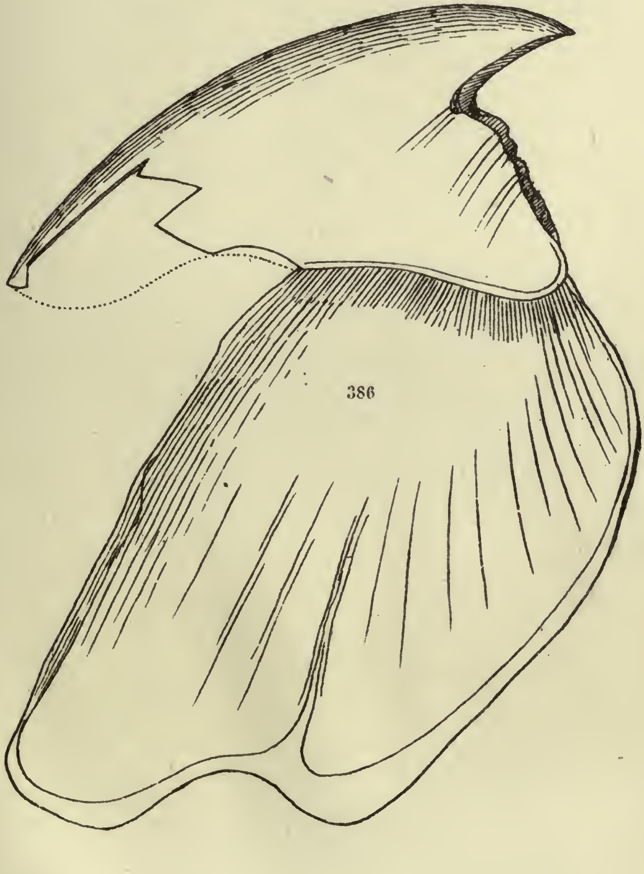

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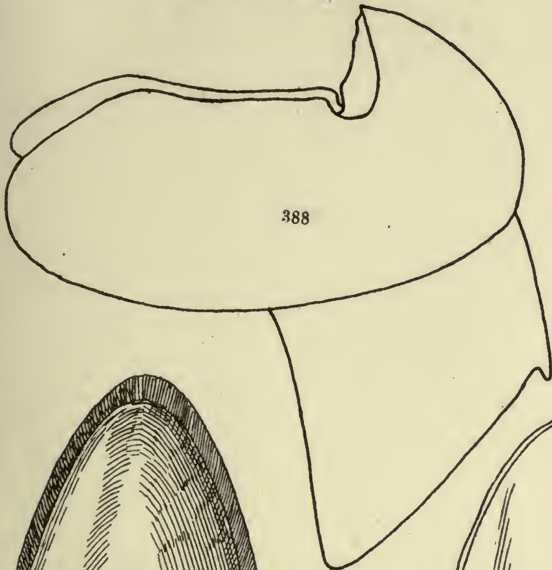

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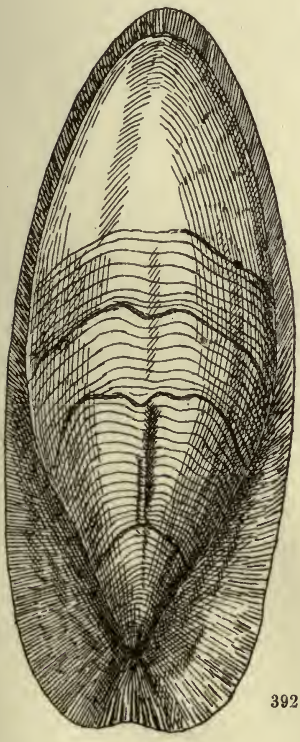

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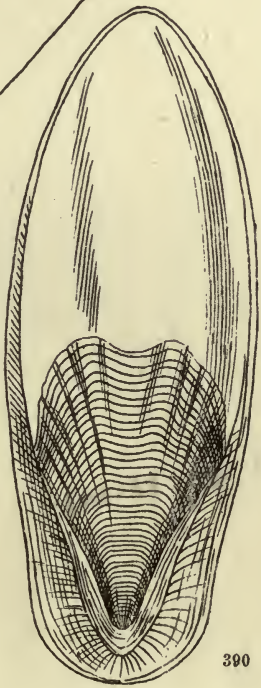

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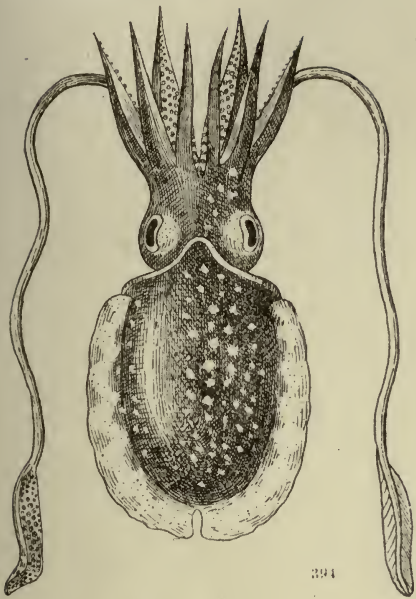

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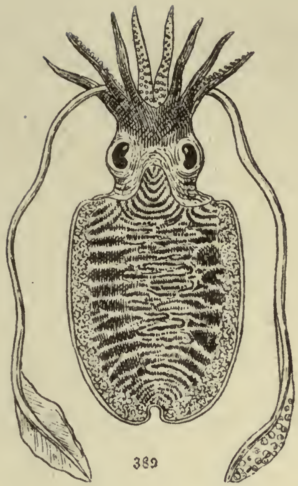

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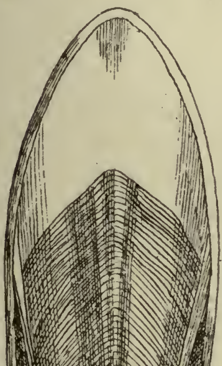

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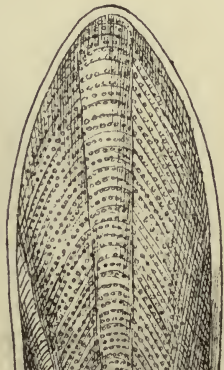

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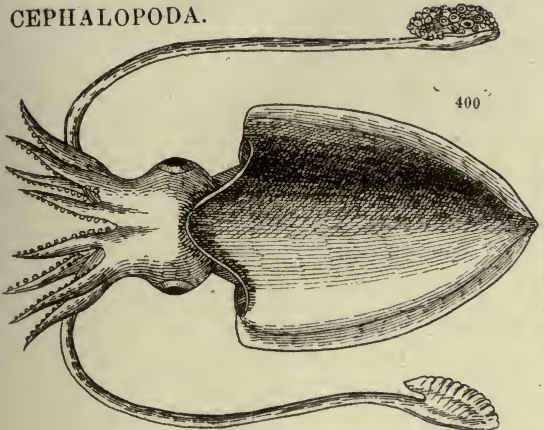

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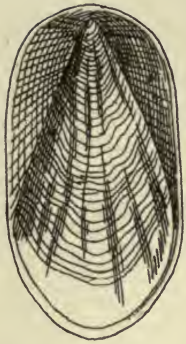

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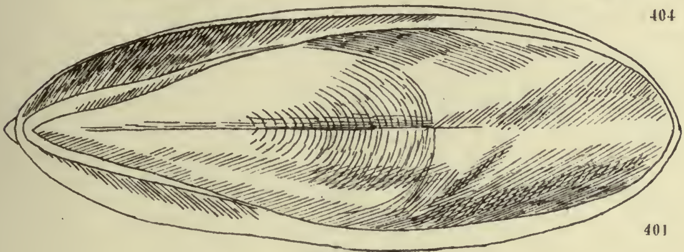

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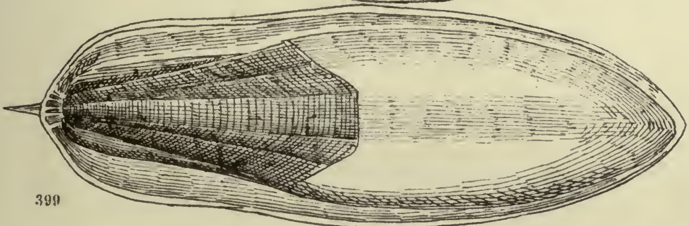

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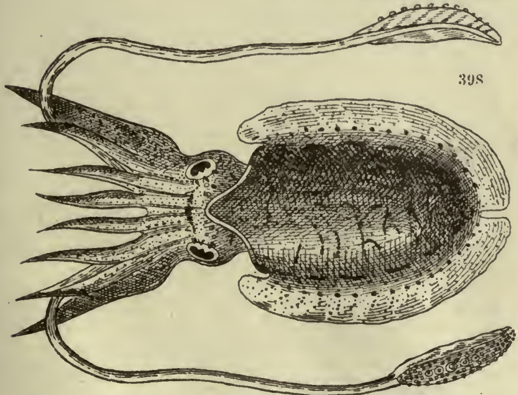

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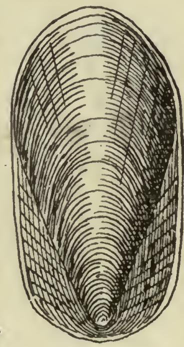

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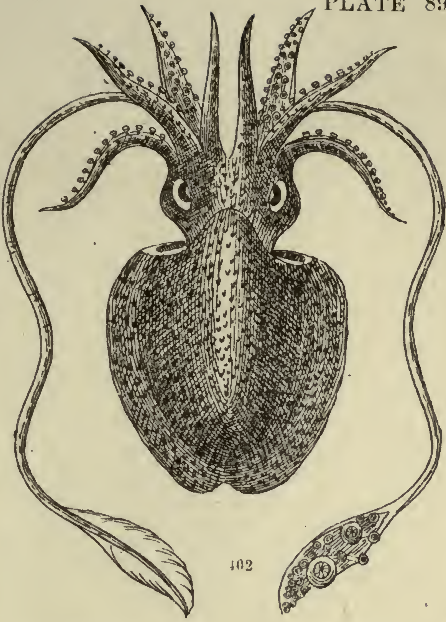

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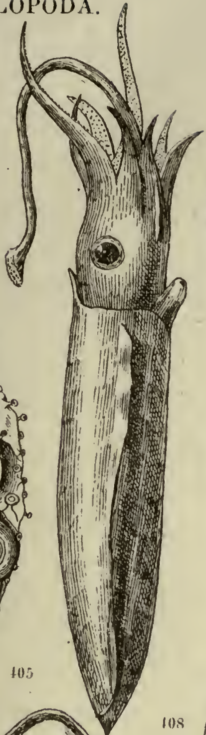

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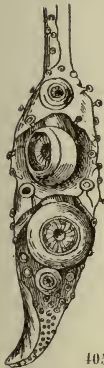

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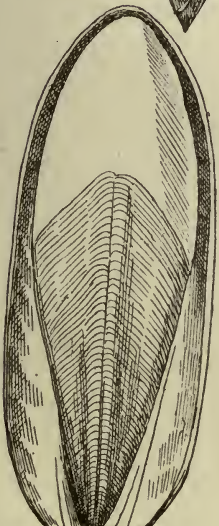

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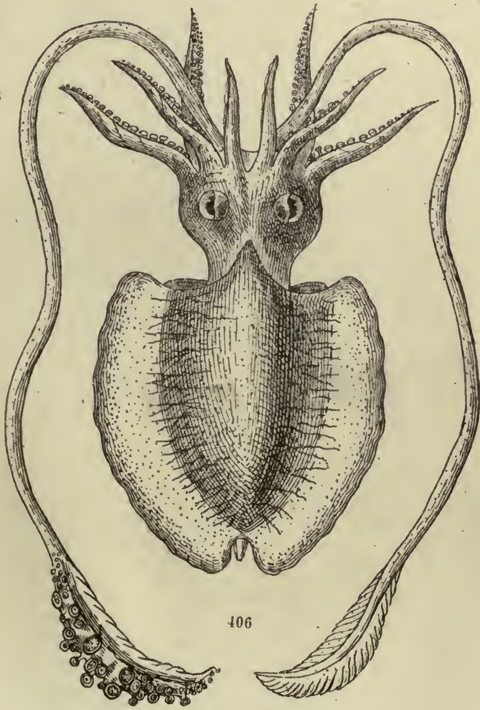

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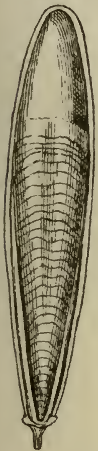

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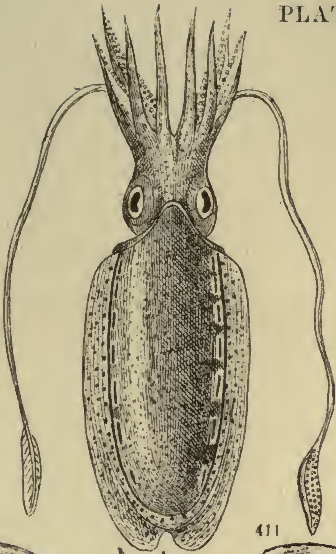

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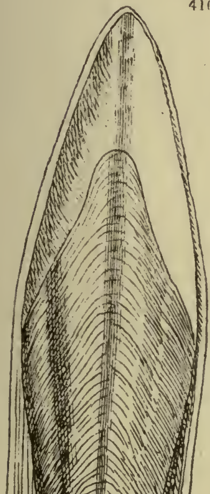

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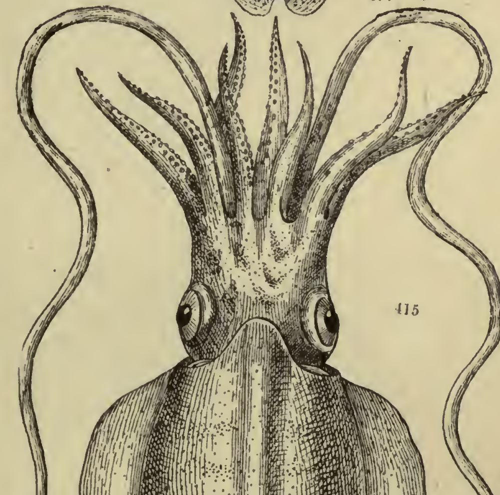

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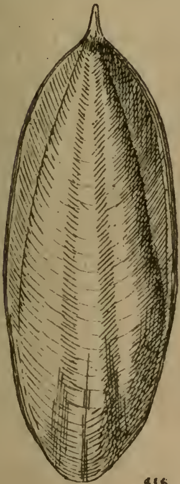

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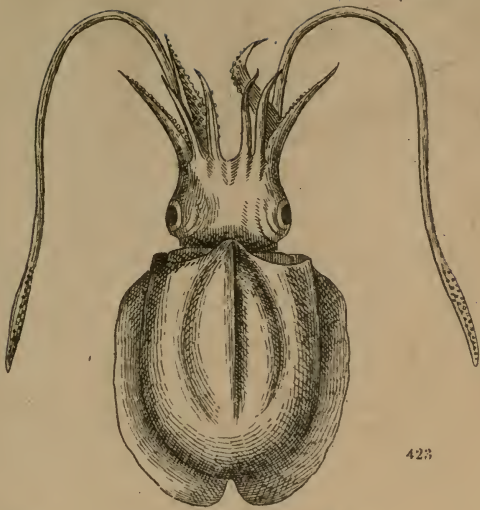

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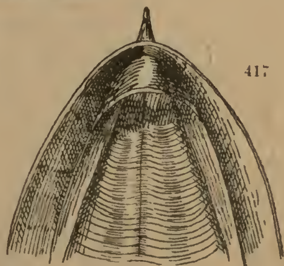

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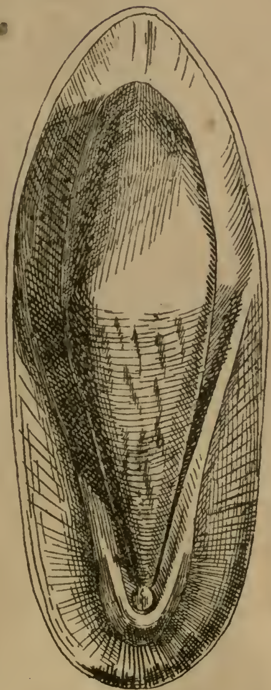

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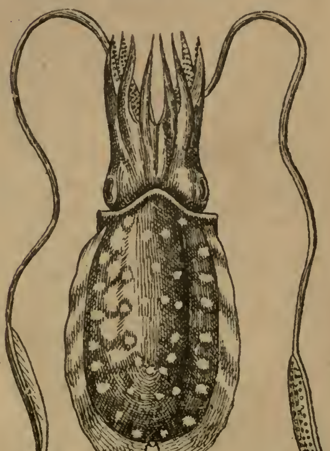

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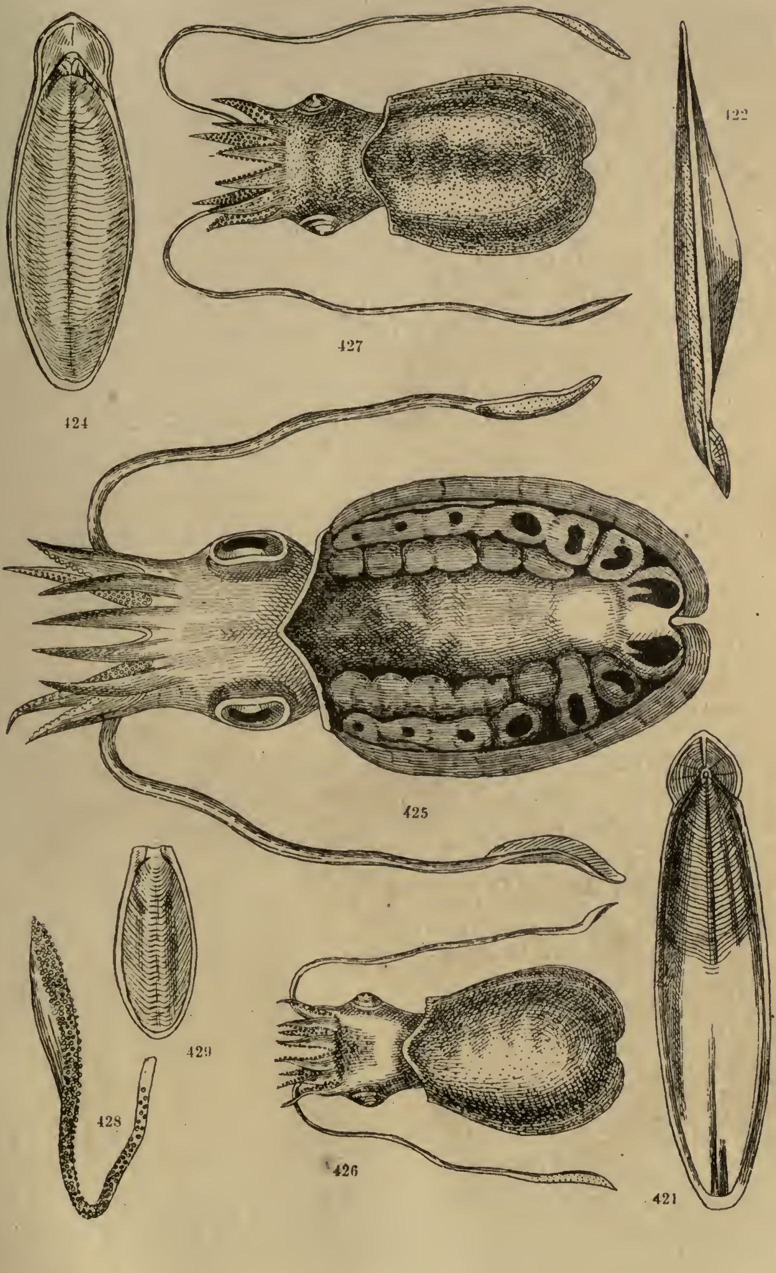
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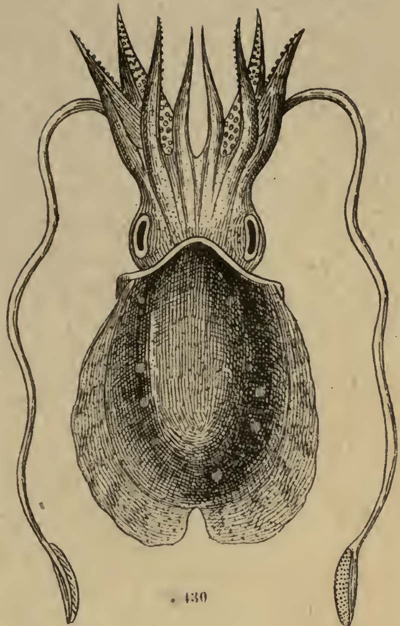

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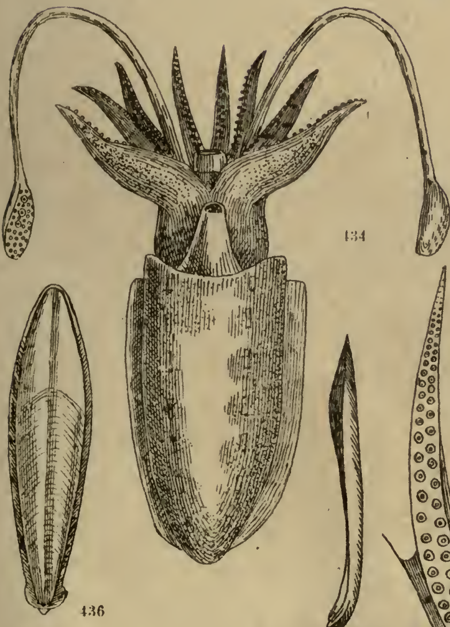

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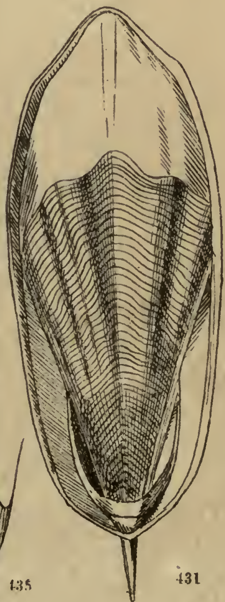

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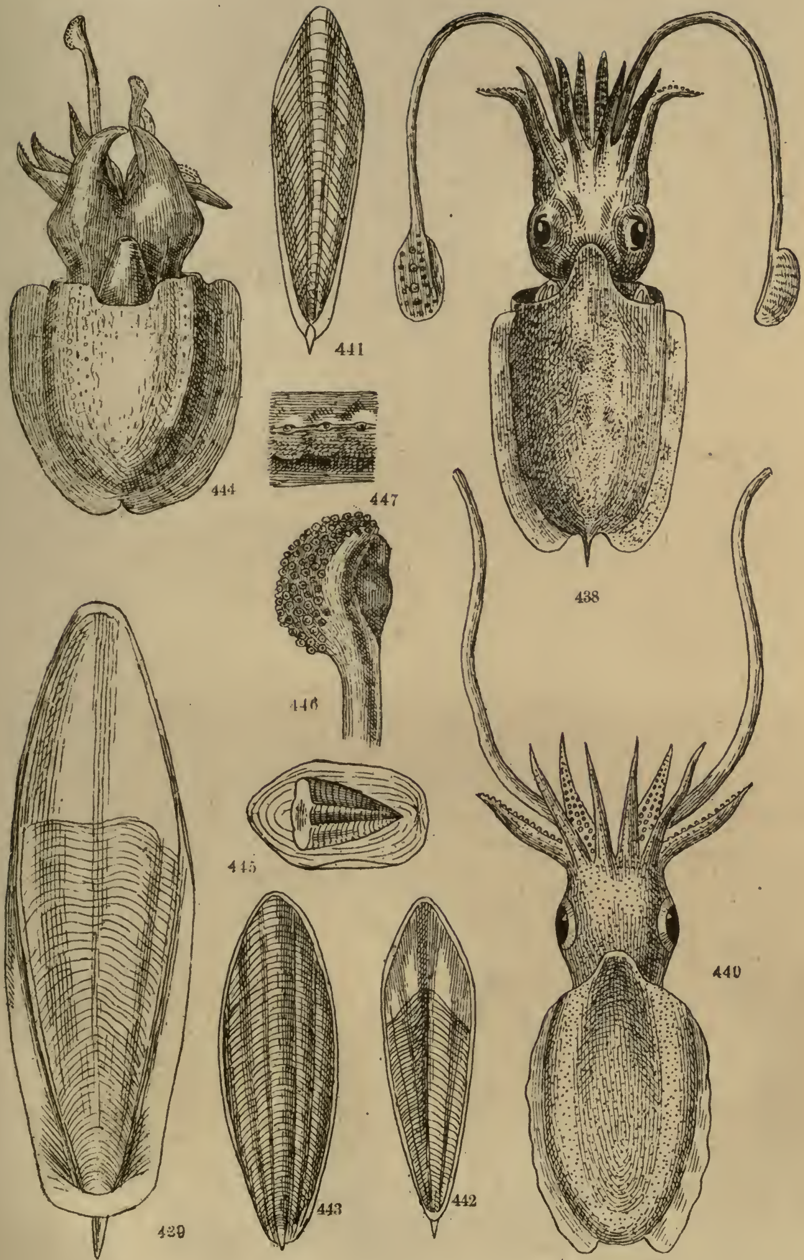
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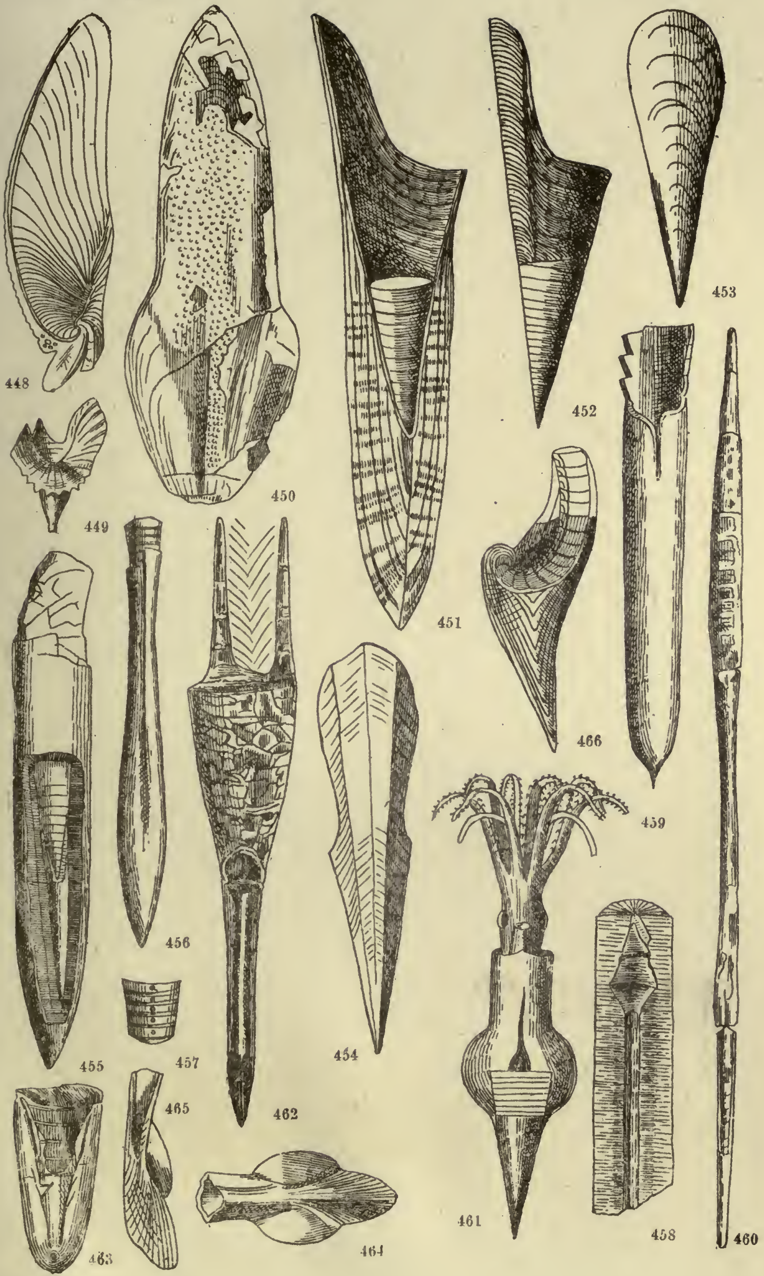
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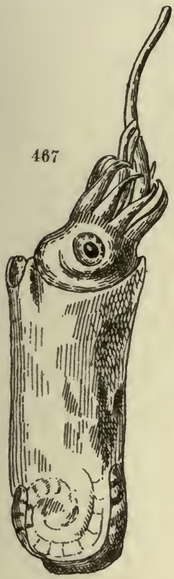
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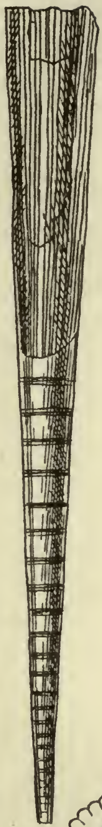
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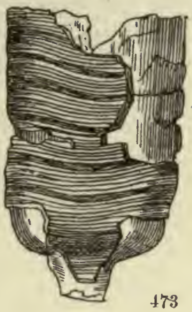
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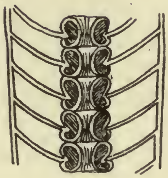
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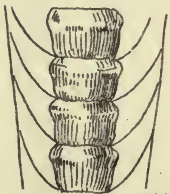
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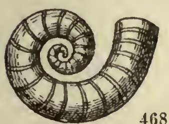
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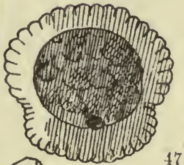
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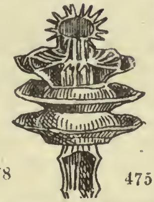
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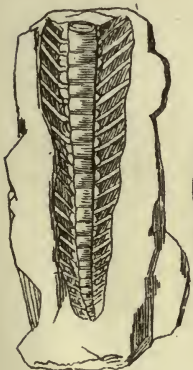
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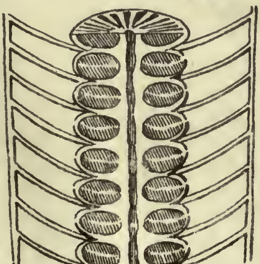
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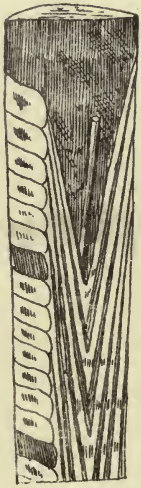
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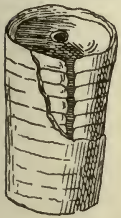
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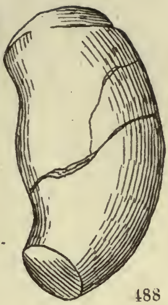
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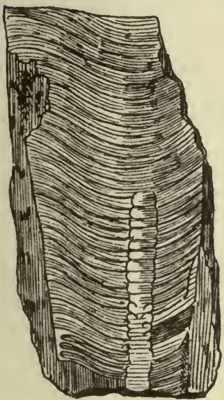
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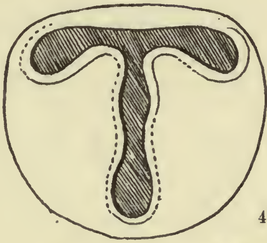
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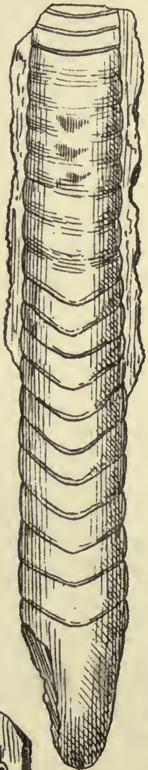
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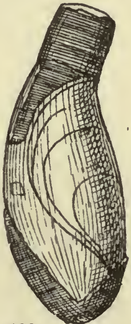
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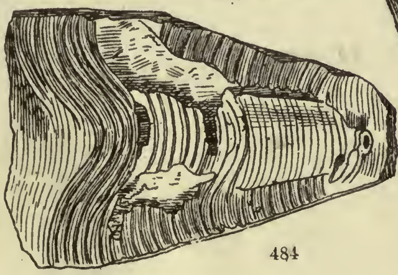
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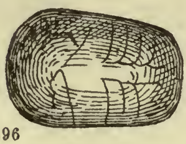
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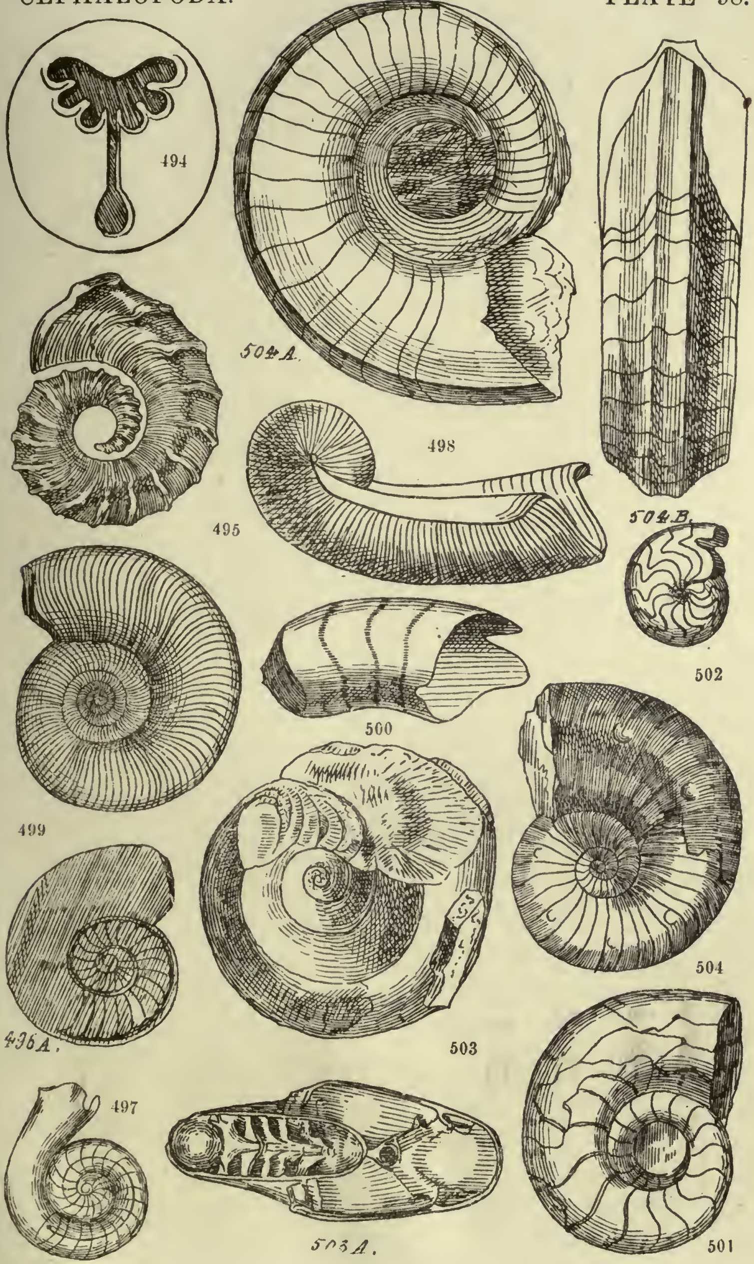
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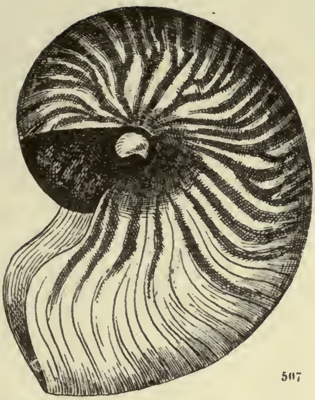

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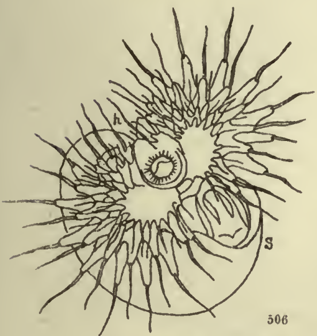

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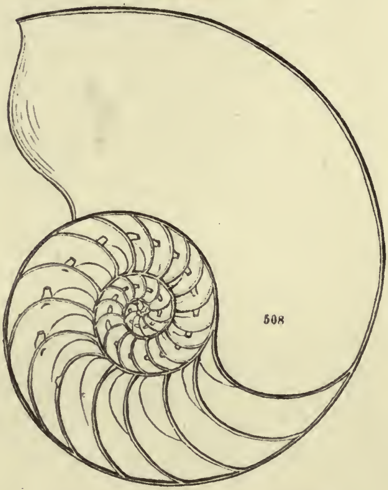

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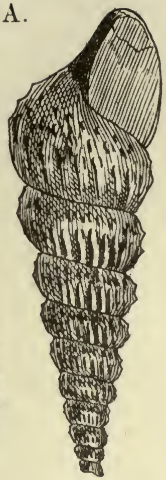

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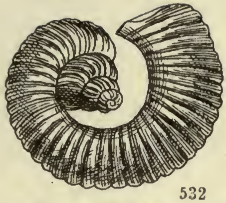

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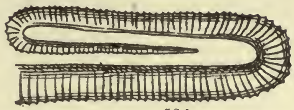

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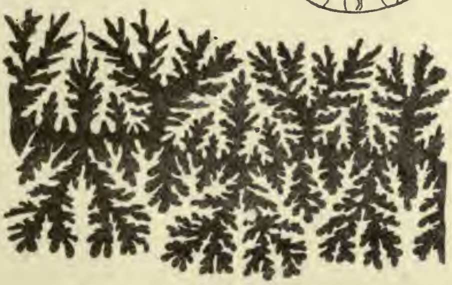

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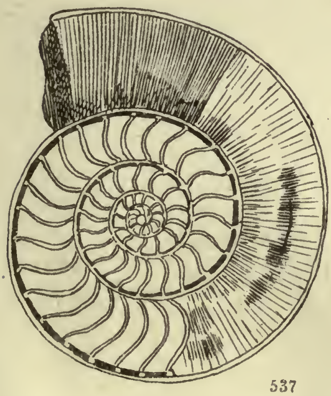

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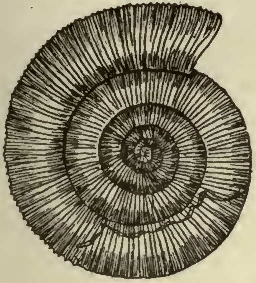
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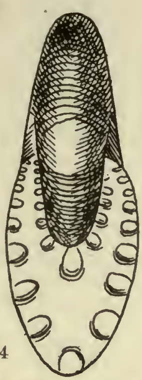
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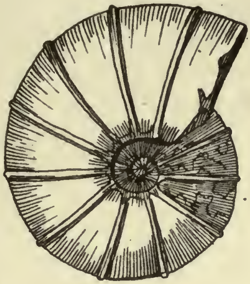
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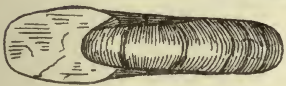
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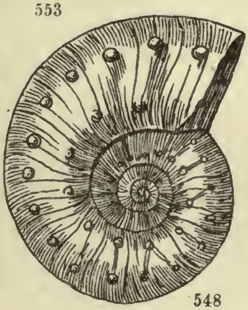
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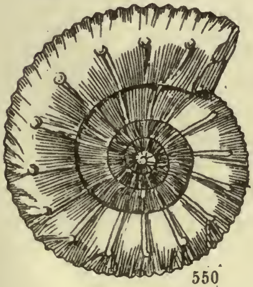
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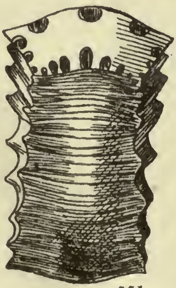
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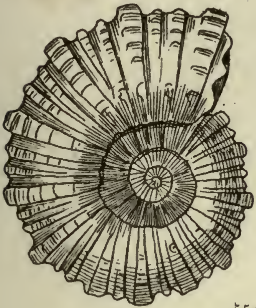
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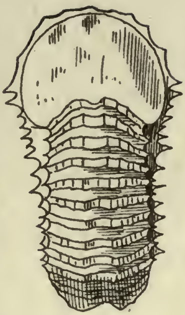
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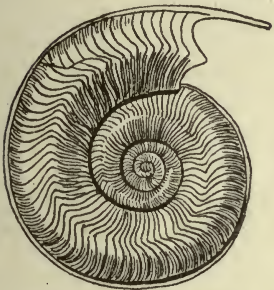
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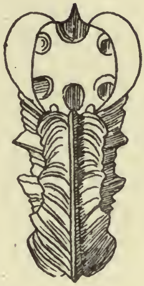
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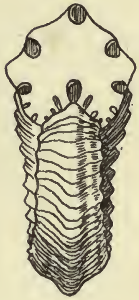
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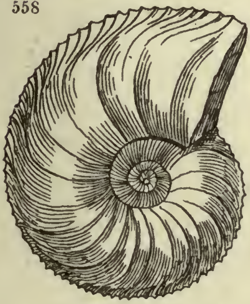
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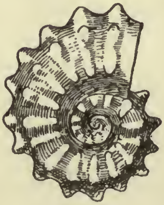
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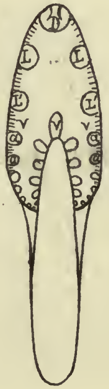
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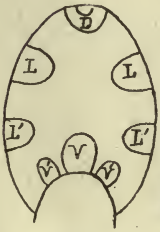

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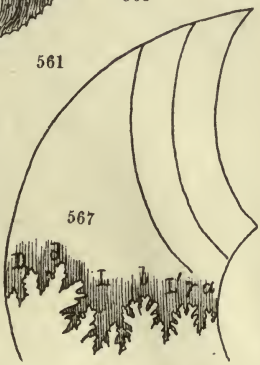
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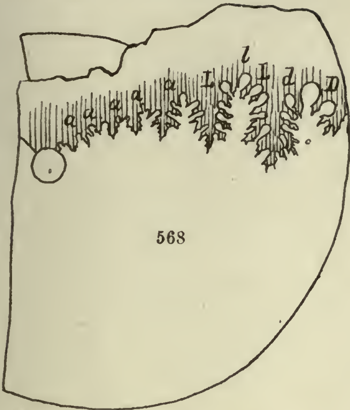
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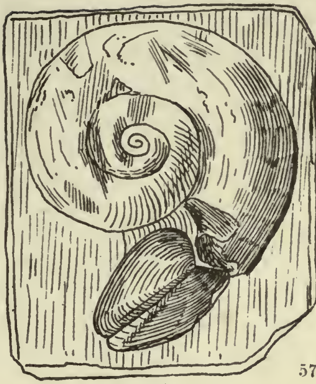
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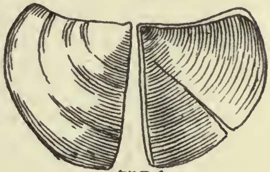
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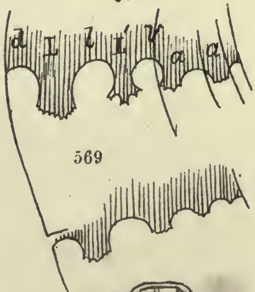
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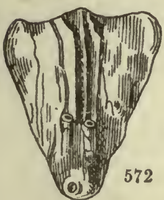
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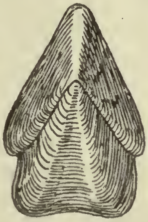
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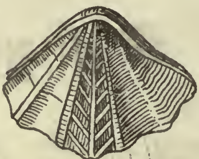
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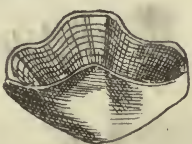
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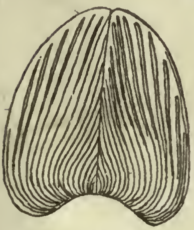
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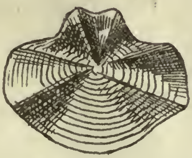
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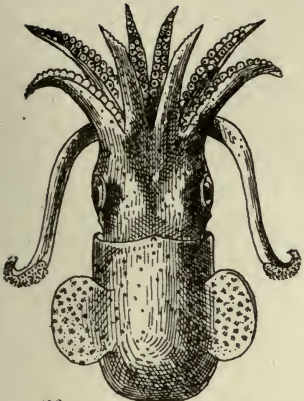

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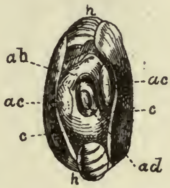

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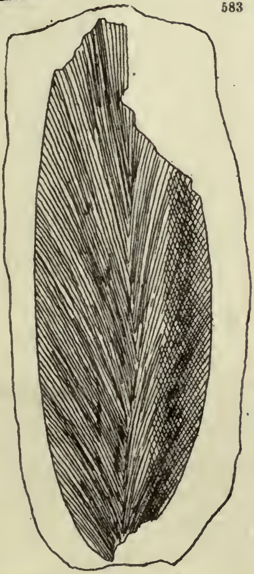

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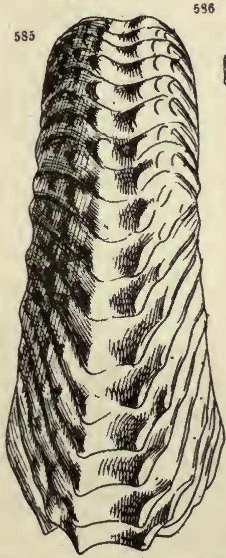

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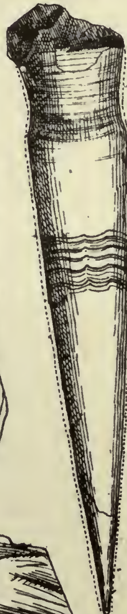

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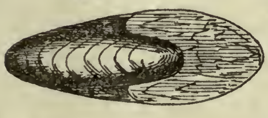

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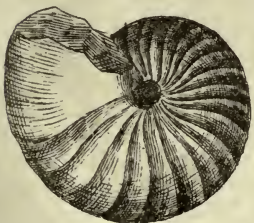

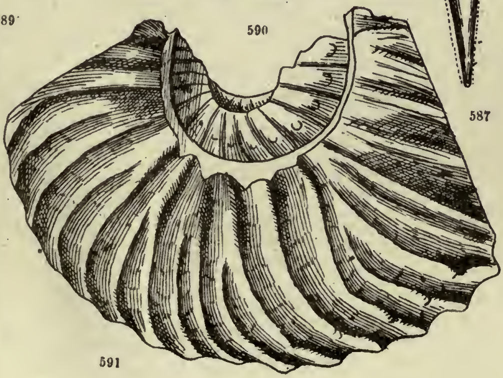

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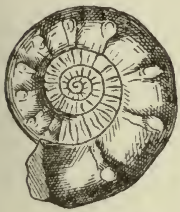

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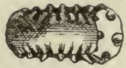

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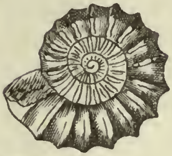

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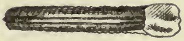

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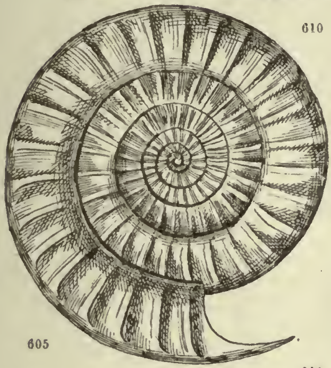

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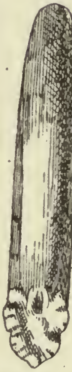

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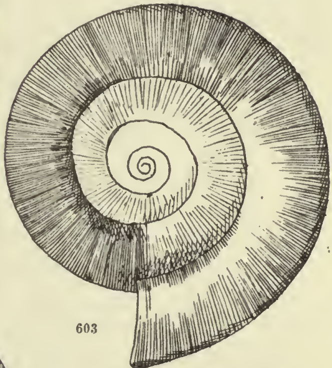

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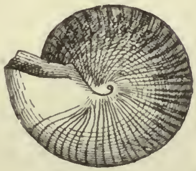

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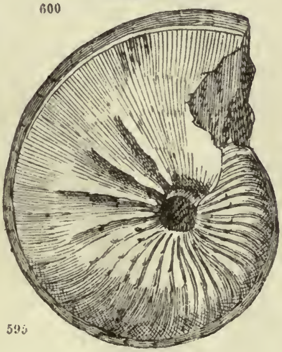

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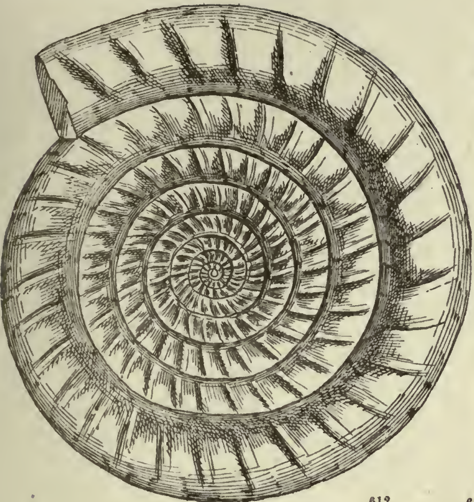

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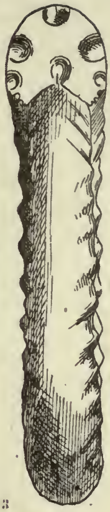

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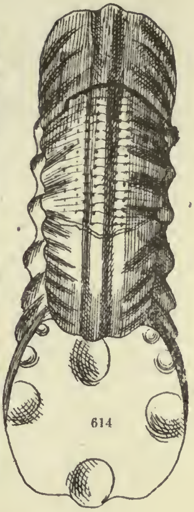

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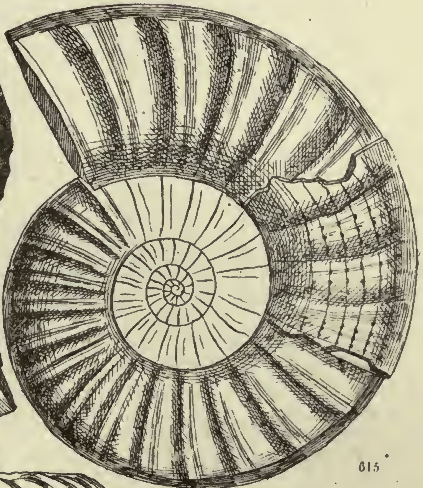

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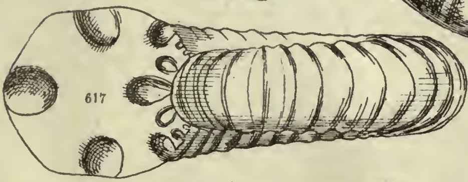

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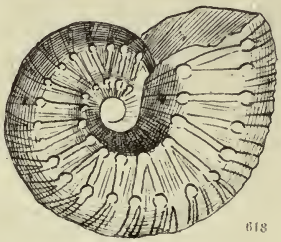

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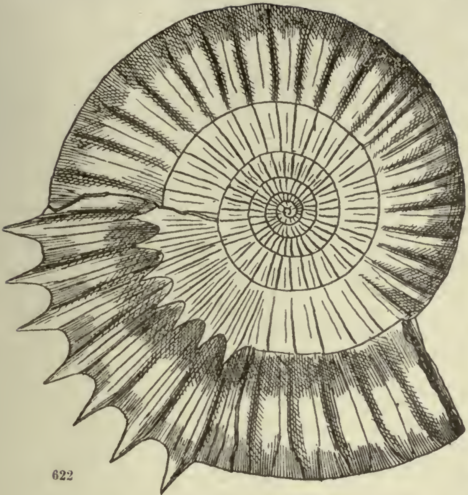

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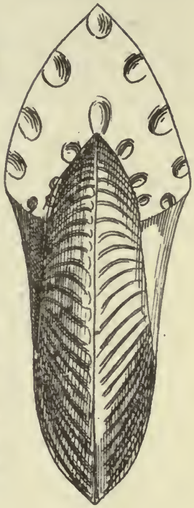

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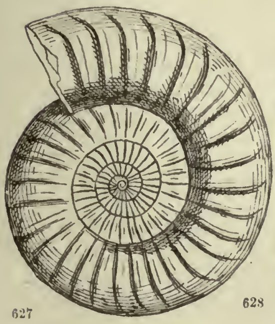

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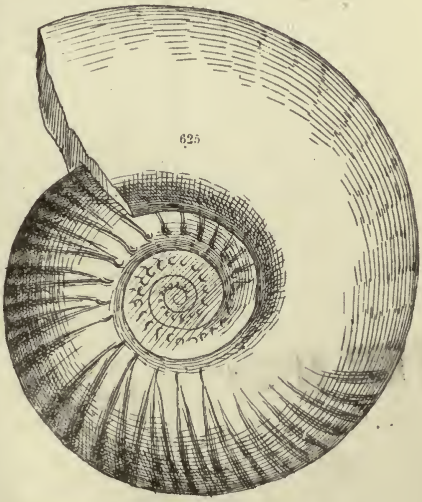

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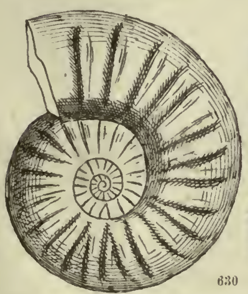

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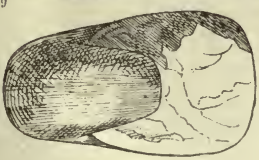

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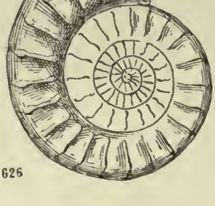

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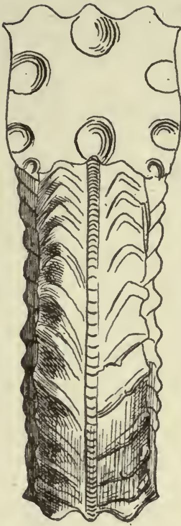

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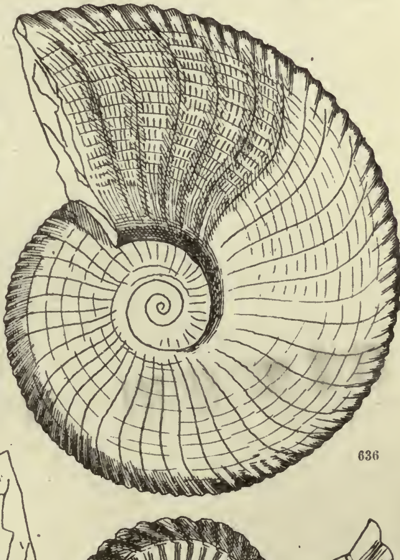

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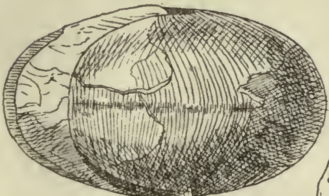

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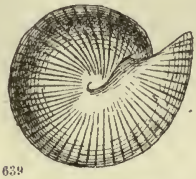

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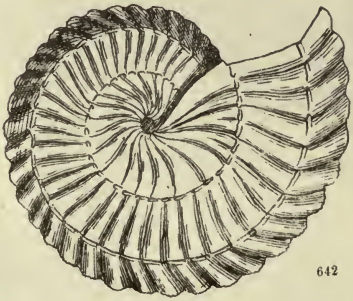

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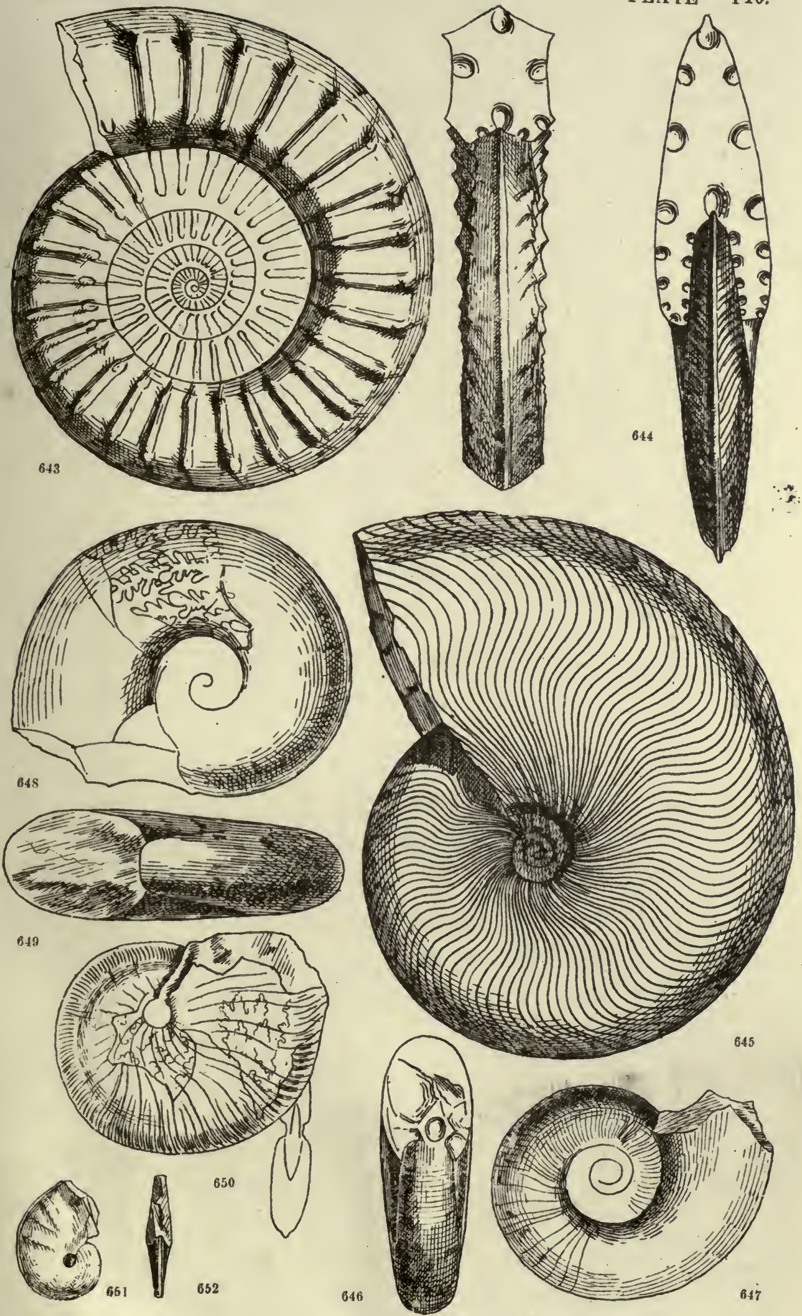
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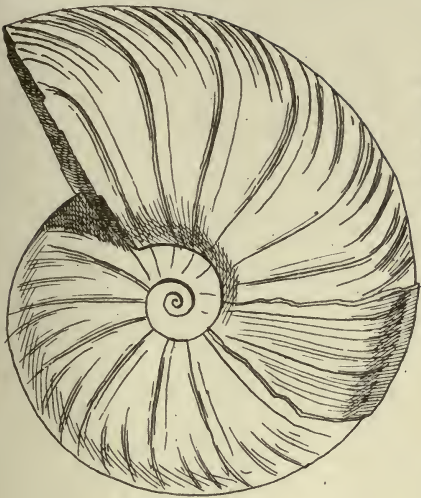

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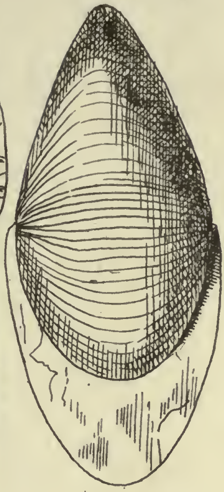

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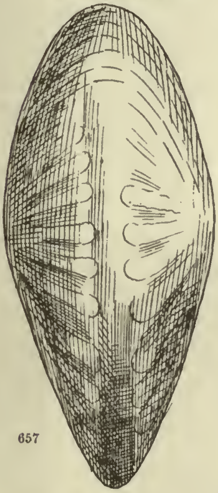

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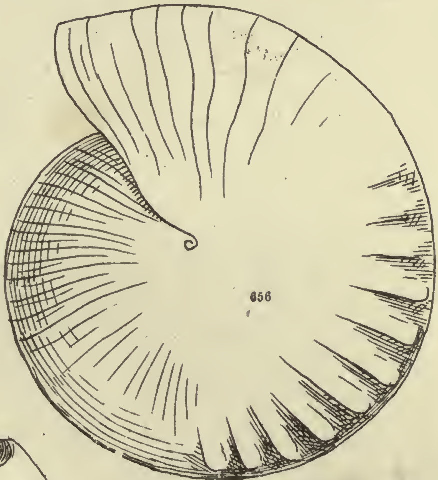

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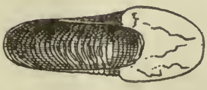

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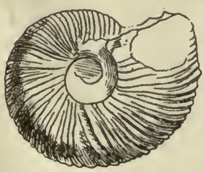

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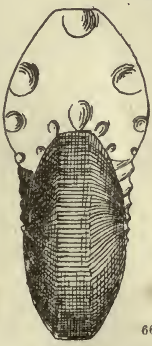

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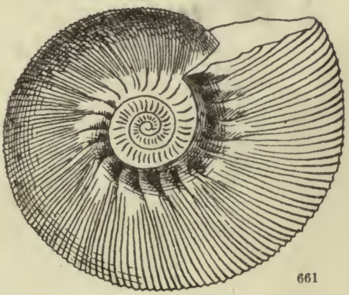

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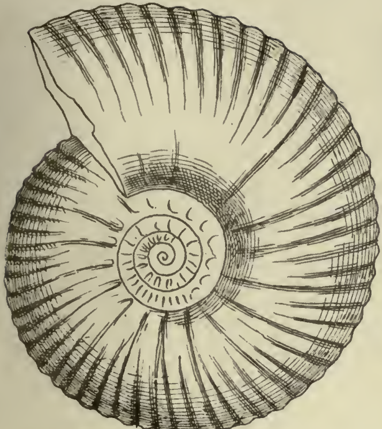

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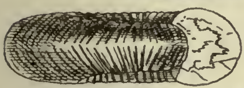

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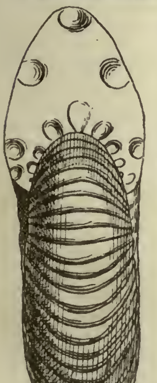

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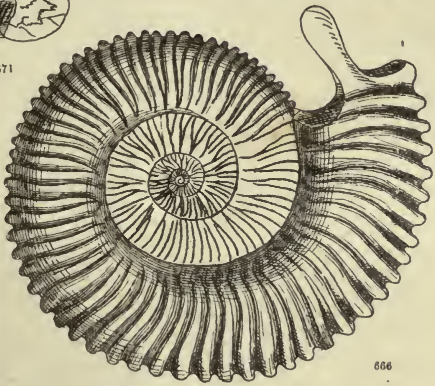

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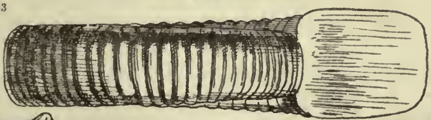

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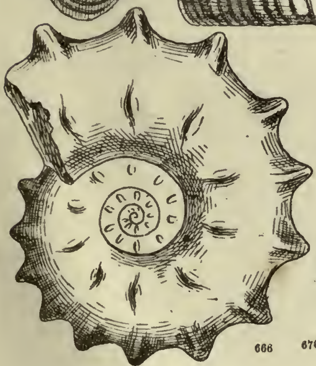

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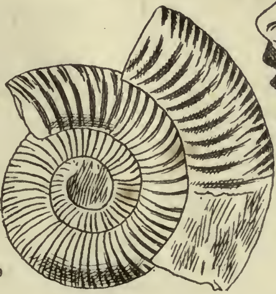

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